EERI sent several reconnaissance teams to Japan, including one on societal and governmental response. This 11-member social science team consisted of academics as well as practicing emergency managers and urban planners, and staff of an international nongovernmental organization. The team was in the field from June 19-26, 2011, roughly 100 days after the earthquake. Hosted by Japanese counterparts with the Institute for Social Safety Science (ISSS), the team visited 11 communities affected by the tsunami in Iwate and Miyagi prefectures, ranging from small towns to metropolitan Sendai (see Figure 1). The team did not travel to Fukushima prefecture, but had opportunities for field observations at a broad range of sites and received formal and informal briefings from government officials (at the local, prefectural, and national levels), non-governmental organizations, community leaders, and academic researchers. The team was made up of the following: Stephanie Chang, University of British Columbia (team leader); Daniel Aldrich, Purdue University; Richard Eisner, California Office of Emergency Services, retired; Laurie Johnson, Laurie Johnson Consulting and Research; Terri Norton, University of Nebraska; Kathleen Tierney, University of Colorado; Tricia Wachtendorf, University of Delaware; Rochelle Brittingham, University of Delaware; Kanako Iuchi, The World Bank; Sahar Safaie, The World Bank; and Jay Wilson, Department of Emergency Management, Clackamas County, Oregon.

Table 1 indicates casualties for communities visited by the field team. The city of Ishinomaki alone had about the same number of casualties (including dead and missing) as Kobe had in the 1995 earthquake, but with a population one-tenth as large. Communities had high levels of tsunami awareness, pre-disaster mitigation (including structural works) and preparedness; however, they had assumed and planned for a smaller tsunami, in part because of expectations set by seismologists regarding the maximum size event possible on their section of the subduction zone. The size of the actual event overwhelmed communities’ pre-disaster risk reduction efforts.

In many communities, the tsunami killed community leaders and destroyed government buildings, emergency centers, designated emergency shelters, hospitals, and other emergency facilities and resources; therefore, it was extremely difficult for local jurisdictions to respond quickly and effectively.

The simultaneous impacts of earthquake, tsunami, and nuclear power plant crises greatly impaired the
capacity of governments to respond, and the multiple disasters now challenge their efforts to facilitate recovery. Moreover, prior to March 11th, the nation had an unpopular government and a weak economy. Both of these circumstances will hinder recovery. The minister who had been appointed on June 27 to lead the recovery effort resigned amid intense criticism on July 5, sparking new calls for the resignation of the prime minister.

It is also important to recognize Japan’s geographic context and constraints. Japan is similar in areal extent to California, contains four times the population, and is 90% mountainous. In addition to earthquakes, there are volcanic eruptions, typhoons, coastal and river flooding, and landslides. In many localities, therefore, mitigation and reconstruction planning for earthquakes is challenged by a lack of space free of risk, and by conflicting or overlapping hazards.

As will be described below, this catastrophe has generated many surprises, unprecedented challenges, and new issues in disaster risk reduction. We believe it is imperative for the U.S. research and practice communities to learn from it through U.S.-Japan collaborative studies and information-sharing, and to incorporate the lessons in addressing the risk of earthquakes, tsunamis, and other potential catastrophes in the United States. This report discusses, respectively, emergency management, casualties, emergency shelter and housing, economic impacts, debris management, and recovery planning.

### Emergency Management

Emergency management in Japan designates local governments and prefectures as the lead agencies for preparedness, mitigation, response, relief and recovery. Local governments are the first responders, while the national government provides response resources. Japan’s Disaster Countermeasures Basic Act requires local and prefectural governments to have disaster plans that include mitigation, emergency response, relief, and recovery. The Ministry of Land, Infrastructure, Transport and Tourism provides local governments with hazard maps, including tsunami inundation projections. It also assists local governments in determining hazards, providing guidance on disaster scenarios, and producing detailed tsunami inundation zone maps, while local governments are responsible for mitigation measures, such as the design and construction of tsunami sea walls, as well as preparedness activities such as local public education, evacuation planning, and selection of refuge areas. The Japan Meteorological Agency (JMA) monitors Japan’s seismic network, determines tsunami potential for earthquakes, and issues warnings and estimates of tsunami wave heights. It is the responsibility of local governments to issue evacuation orders and to initiate response and relief efforts.

The catastrophic consequences of the March 11th earthquake challenged the response hierarchy. At the local level, many jurisdictions lost command and management facilities, key staff were killed in the tsunami, and communications were destroyed by damage to facilities and infrastructure and loss of power. For example, the town of Otsuchi lost its mayor, seven senior staff, and 31 other municipal employees in the tsunami. In Minamisanriku, the community’s emergency operations and tsunami warning center was overtopped by the tsunami waves as staff were broadcasting evacuation orders (Figure 2). Only ten staff members survived by clinging to antenna masts on the roof of the structure. The inability of...
local staff to document and report up the hierarchy, and to request assistance and support, delayed response from the prefecture and national level of government.

Tsunami inundation and damage extended for 600 km along the coast and up to 6 km inland in estuaries and coastal plains. It was the first disaster in Japan to be declared a “level 3” event, one that affected multiple prefectures and in which a significant amount of mutual aid was moved from prefectures outside the area into damaged prefectures and local governments.

The emergency response was also complicated by the damage and radioactive releases at the Fukushima Daiichi nuclear power facility, which required mass evacuation of residents and may have competed with the tsunami response for attention of the government and for resources.

Table 2. Historic Tsunamis on the Tohoku Coast

<table>
<thead>
<tr>
<th>Year</th>
<th>Earthquake</th>
<th>$M_{\text{eq}}$</th>
<th>Max. Run up Height (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>869</td>
<td>Jogan-Sanriku</td>
<td>M 8.3 – 8.6</td>
<td>Paleo-Tsunami sand deposits found 4 km inland on Sendai plain</td>
</tr>
<tr>
<td>1611</td>
<td>Keiho-Sanriku</td>
<td>M 8.1</td>
<td>20m</td>
</tr>
<tr>
<td>1896</td>
<td>Meiji Sanriku</td>
<td>M 8.2 – 8.5</td>
<td>38m</td>
</tr>
<tr>
<td>1933</td>
<td>Showa Sanriku</td>
<td>M 8.1</td>
<td>28.7m</td>
</tr>
<tr>
<td>1960</td>
<td>Chile</td>
<td>Mw 9.5</td>
<td>5.3m</td>
</tr>
<tr>
<td>2011</td>
<td>Great East Japan Eq.</td>
<td>Mw0.0</td>
<td>38 – 40m</td>
</tr>
</tbody>
</table>


Planning Assumptions for a Tohoku Earthquake and Tsunami.

To some degree, problems with the overall intergovernmental response can be traced to the underestimation of the hazard and resulting consequences of the quake. All projections of tsunami wave height, extent of inundation, required seawalls, evacuation routes and refuge areas, heights for structures to be used for vertical evacuation, and response planning were based on a recurrence of the 1896 Meiji Sanriku or 1960 Chile tsunamis. These were selected as scenario events for disaster management planning because they were thought to be the most likely events (see Table 2). The larger Jogan earthquake and tsunami of 869, which involved tsunami waves significantly larger than either of the mentioned disasters, was viewed as an “outlier,” a 1,000-year event that was low probability. The planning scenario supposedly depicted a high-probability “100 year event.”

Many different measures had been put in place in preparation for the scenario event. Coastal villages and towns in Iwate and Miyagi prefectures planted dense pine “tsunami forests” to dissipate tsunami wave energy, sea walls were constructed to protect harbors and low-lying areas (Figure 3), speakers were installed to provide voice warnings to residents and visitors (Figure 4), radio and television broadcasters could scroll messages...
from the JMA, wave height (Figure 5), and evacuation instructions to the population (Figure 6), and tsunami inundation maps were prepared and posted, directing residents to tsunami refuge areas above the 5.3 meter expected wave heights (Figures 5, 7 and 8). Multistory concrete buildings were designated as tsunami evacuation sites, and the population of this region was instructed to observe “tsunami tendenko.”

After thousands of residents died in the tsunamis in 1896, 1933, and 1960, the local communities adopted a “culture of tsunami tendenko,” a concept that promotes trust that if each individual evacuates, some family members may survive (Tatsuki). The phrase literally means “run, without concern for others and as hard as one can in the time of tsunami coming” (Suzuki). Tsunami tendenko is referenced in SEEDS Asia, 2011; and Suzuki et al., 2011.

The high death toll and devastating effects of the tsunami are leading Japan to reassess its hazard mitigation and life-safety policies. On June 26th, a government-appointed technical investigation panel under the Central Disaster Management Council issued a report recommending the “overhauling…of Japan’s tsunami response measures…to cope with the largest tsunami that can be expected…” (Asahi Shimbun, 6/28/11). The report recommended that “countermeasures should focus on how to evacuate residents, instead of relying on seashore protection,” and that “evacuation routes should be set so that children and elderly residents can evacuate without difficulty….” The report also recommended the construction of structures for vertical evacuation in areas “without high ground,” improvements in real-time earthquake assessment to speed determination of magnitudes and potential for tsunami generation, and a review of evacuation training measures.

The Earthquake and Tsunami.

The earthquake struck at 2:46 p.m. local time (14:46 JST or 05:46 UTC), 130 km ESE of the Oshika Peninsula. Within eight seconds of the nucleation (after the initial P-wave hit), an Earthquake Early Warning (EEW) message was is-

Figure 5. Tsunami height marker, 1960 Chile tsunami, Ofunato Town (in 2010). The sign reads: “Disaster attacks when you forget” (photo: R. Eisner).

Figure 6. Tsunami wave height and direction sign, Ofunato Town (in 2010) (photo: R. Eisner).

Figure 7. Tsunami evacuation sign, Ofunato Town (in 2010) (photo: R. Eisner).

Figure 8. Tsunami evacuation map, Ofunato Town (in 2010) (photo: R. Eisner).
sued by the JMA, providing 5-10 seconds warning of the arrival of the S-wave to the nearest coastal areas. Approximately three minutes later, JMA issued a Tsunami Warning to three coastal areas in close proximity to the epicenter for a “3-meter or higher” wave. The warning was broadcast over the radio, as a “scroll” on television, over speaker systems in populated coastal areas, and as a text message to cell phones in proximity to the epicenter.

The initial estimate of the earthquake’s magnitude, based on the rupture of the initial segment of the fault, was 7.9 and was broadcast, but the earthquake propagated into a three-segment mega-thrust subduction rupture, and the magnitude was eventually updated to $M_w$ 9.0, becoming the largest earthquake ever recorded in Japan. The earthquake intensity was 7 on the JMA scale, the scale’s maximum intensity. (The March 11 quake was preceded by several foreshocks, including an $M_w$ 7.2 tremor on March 9, and succeeded by five aftershocks greater than $M_w$ 7.)

The Response. While the strong motions of the earthquake lasted four minutes, the tsunami inundation cycle continued for several hours, limiting response actions on the afternoon and evening of March 11. It was not possible during our brief reconnaissance visits to numerous Tohoku communities to create a time history of response actions in each community; however, Table 3 identifies key actions by the national government in initiating response.

Emergency response agencies were confronted with several challenges. First, electrical power was cut, and then radio, landline telephone and cellular communication were disrupted, preventing early reporting of damage and response needs. Access to satellite telephones was limited and inadequate to fill the communications gap. Highway and rail lines along the coast were destroyed, and access from the major highways to the west was blocked in many places by road damage and landslides. Marine access from the Pacific Ocean side of Iwate, Miyagi, and Fukushima prefectures was blocked on the first day by continuing tsunami action, and later by damaged dock facilities and floating debris. Fuel for vehicles and equipment was not available due to loss of power and damage to facilities.

Prior to the disaster, the Japanese government had established a “Wide-Area Support System,” which can be used to mobilize a range of response resources available to the national government: National Police Agency Inter-Prefectural Emergency Rescue Units; Fire and Disaster Management Agency Disaster Medical Assistance Teams (DMAT); and resources of the Japan Coast Guard. This system can dispatch Self-Defense Force (SDF) personnel, as well as DMAT teams and ambulances for victim transport to hospitals outside the damaged areas. The reconnaissance team could not determine whether the national resources were dispatched based on prefectural requests or by a national government initiative (an “event trigger”).

By March 12, SDF personnel were en route to the damaged prefectures, but their access to the coastal communities was slowed by blocked highways. In the days following the earthquake and tsunami, nearly half the personnel of Japanese SDF, 100,000 personnel, were dispatched to undertake response activities. Gaining access to remote communities and clearing road access became the priority, with the SDF taking the lead and U.S. military providing logistical support in “Operation Tomodachi” (Operation Friend). The US provided personnel and “across the beach” access using military landing craft and air boats to transport heavy equipment for debris removal. SDF forces with both domestic and foreign search and rescue teams took on rescue and body recovery from areas flooded by the tsunami.

The scale of the tsunami disaster, added to the damage to communications infrastructure, frustrated initial efforts to assess damage and determine relief needs. Helicopters from the military and prefectures were dispatched to do an aerial survey of the affected areas, and later to deliver food and water to stranded survivors. Table 4 summarizes resources committed to response.

Table 3. Initial Response by the National Government

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 March</td>
<td>14:46</td>
<td>$M_w$ 9.0 earthquake nucleation offshore of Sanriku. Three prefectures impacted simultaneously</td>
</tr>
<tr>
<td></td>
<td>14:50</td>
<td>Response Office established in Prime Minister's Office. Emergency Response Team convened</td>
</tr>
<tr>
<td></td>
<td>15:14</td>
<td>Established “Extreme Disaster Management Headquarters” headed by the Prime Minister (first establishment of function since passage of Basic Law)</td>
</tr>
<tr>
<td></td>
<td>15:37</td>
<td>Convening of Extreme Disasters Management Headquarters (adopted basic policy on response to the disaster and Disaster Relief Act)</td>
</tr>
<tr>
<td></td>
<td>18:42</td>
<td>Dispatched government inspection team to Miyagi Prefecture</td>
</tr>
<tr>
<td></td>
<td>19:23</td>
<td>Extreme Disaster Management Headquarters meeting on relief measures for stranded commuters</td>
</tr>
<tr>
<td>12 March</td>
<td>06:00</td>
<td>Established Local Headquarters for Extreme Disaster Management in Miyagi Prefecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Designation of event as an Extremely Severe Disaster</td>
</tr>
<tr>
<td>13 March</td>
<td></td>
<td>Designation of event as a Specified Major Disaster</td>
</tr>
<tr>
<td>14 March</td>
<td></td>
<td>Decision to liquidate reserve fund to purchase relief supplies</td>
</tr>
</tbody>
</table>

Source: Cabinet Office, Government of Japan, 2011
In many of the devastated communities, shelters were without food or water for nearly three days. Iwate Prefecture dispatched staff to devastated local communities to re-establish civil government functions. Adjacent prefectures and those with recent experience in disasters also dispatched personnel to assist local governments where officials had been killed or injured, and to contribute their experience in response, relief, and reconstruction efforts.

International search and rescue teams from the United States, South Korea, Singapore, Germany, Switzerland, China, the United Kingdom, Mexico, Australia, New Zealand, France, Taiwan, Russia, Mongolia, Turkey, Indonesia, South Africa, Israel, and India offered their services to local governments through the national government (The Japan Times Special Report). The national government offered these resources to local governments, but there was no initial response. Teams were eventually dispatched directly to local areas, but most returned to their home countries within two to six days when they realized that their primary function was body recovery, a task more appropriately undertaken and sustained by the SDF.

### Table 4. Response and Rescue Operation Resources Provided

<table>
<thead>
<tr>
<th>Resources Provided</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Police Agency staff (307,500)</td>
<td>Mission not defined in White Paper</td>
</tr>
<tr>
<td>Fire and Disaster Management Agency initially dispatched 1,550 Emergency Fire Teams and 6,099 staff (27,373 teams and 103,690 staff by 31 May)</td>
<td>Search and Rescue/Recovery</td>
</tr>
<tr>
<td>Japan Coast Guard dispatched 4,413 boats, 1,564 aircraft and 1,510 special rescue teams</td>
<td>Not stated if numbers reflect number of resources (“boats”, “teams”) or number of missions</td>
</tr>
<tr>
<td>Ministry of Defense (Self Defense Force [SDF]) dispatched 107,000 personnel</td>
<td>Search and Rescue/Recovery, logistics, medical transport, care and shelter operations</td>
</tr>
<tr>
<td>28 countries provided Search and Rescue teams</td>
<td>See text below</td>
</tr>
<tr>
<td>U.S. provided 16,000 personnel, 15 ships and 140 aircraft to support response</td>
<td>Operation Tomodachi</td>
</tr>
<tr>
<td>193 Disaster Medical Assistance Teams dispatched</td>
<td>Could not determine duration or mission of DMAT Teams</td>
</tr>
</tbody>
</table>


Victim Registration and Tracking.
The limited capacity of many local governments in the affected area has precluded implementation of a robust disaster registration or tracking system. Persons displaced and living in regional shelters or in other prefectures may not be receiving formal communications about property damage certificates, demolition, reconstruction and recovery from their municipality or prefecture. This is especially true for disabled populations requiring special assistance. Privacy laws in each local government meant to protect recipients of government assistance may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals. Interpretation of these privacy laws by local government administrators may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals. Interpretation of these privacy laws by local government administrators may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals. Interpretation of these privacy laws by local government administrators may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals. Interpretation of these privacy laws by local government administrators may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals. Interpretation of these privacy laws by local government administrators may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals. Interpretation of these privacy laws by local government administrators may be limiting their access to post-disaster assistance, preventing nongovernmental organizations (NGOs) that provide social services from contacting or tracking the whereabouts of these vulnerable individuals.

Transitioning to Recovery.
The national government has established emergency headquarters in Tokyo (separating response to the Fukushima Daiichi nuclear plant accident from response to the earthquake and tsunami) and a "field office" in Sendai, where representatives of the prefectures and national agencies with responsibilities for relief and recovery are located. Similar field offices were established in Iwate and Fukushima prefectures. The main task of the field offices was to collect information from the prefectures, cities, and towns, and to pass on situation reports to Tokyo; now these offices will assist in recovery planning and reconstruction. Local governments are awaiting information about available funding from the national government, along with revised hazard assessments needed to guide land use and reconstruction planning.

Suggestions for Research:
- There is a need to understand the effectiveness of tsunami education and response approaches. Research should identify and map all factors that may have affected the evacuation process: location in relationship to mapped inundation zones, age, sex, disability,
relationship to caregiver, topography, notification modes, “milling” opportunities, terrain/topography, horizontal/vertical distance to safe refuge, and time of notification.

• There is a need to identify and assess gaps between the Japanese emergency management system as documented and its actual operations in the disaster. Assess the system from local levels to the national, including “time histories” for response and relief actions by selected communities, and determine causes of variation, particularly requests for assistance and for establishing care and shelter operations, disaster information management systems, and situational awareness issues from local to national levels.

Casualties

As of late July, the Japanese National Police Agency (Keisatsu chō, NPA) stated that more than 22,000 residents in the Tohoku region lost their lives in the tsunami (see http://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf for specific numbers). Of those, 92.4% died by drowning, 1.1% by burning, 4.4% by crushing, and the remaining 2.0% by unspecified means. Perhaps due to the offshore nature of the earthquake, the relatively low levels of (local) ground shaking, and high standards for building construction, few deaths were due to the earthquake itself (that is, caused by shaking, landslides, and other geological effects). The damage from the inundation (which reached as high as 10m in some areas) and run-up (which reached as high as 40+ m) was especially concentrated in the northeastern prefectures of Miyagi and Iwate, with some additional deaths in Fukushima, Ibaraki, and Chiba prefectures.

Casualties resulting directly from the inundation varied tremendously by location. In Sendai, with a population of more than 1 million, 755 people perished, or 0.07% of the total population. In Rikuzentakata, out of a population of 23,300, more than 2,100 people died—more than 9% of the population. In Otsuchi, more than 1,600 people perished out of a total population of 15,300—more than 10% of the population (see Table 1 for additional data). Given this variation, the pressing question for social scientists and observers is what accounts for the differences across localities.

Our study visit to Iwate and Miyagi Prefectures allowed the team to ask decision makers, local residents, and NGOs for their explanations. Informed by our own past research on earthquakes, tsunamis and disasters in Japan and other countries, and aided by observations from our Japanese contacts, we think explanations for the differences can be categorized into two main areas: technocratic and human factors. Technocratic factors include geography and topology, distance to shelter, and pre-disaster land use; human factors include the time of the event, limited mobility, caregiving behavior, inaccurate conclusions drawn from past tsunami experiences, disaster preparedness, and the instinct to protect property.

In some communities, the shape of the bay or port, along with its depth, channeled the wave deeply inland and increased its height. In other areas, due to a more southward-facing opening, ports escaped with less damage. There were higher casualty rates on larger plains areas with more houses where the distance to higher ground was longer and the gradient steeper. Pre-disaster land use and the location of the bulk of residential houses also may have influenced survival outcomes. Some localities had high percentages of their population immediately adjacent to the sea walls, while in other areas, residential neighborhoods were located on comparatively safer higher ground (such as in Taro, where many had chosen to relocate to higher altitude after past tsunamis).

Human factors were cited by many of our informants as the core reasons for deaths. That the elderly and infirm are more vulnerable to disaster is well-established from innumerable disasters, and the Tohoku tsunami was no exception. Many of the dead were elderly (Cabinet Office, 2011)—with the mean age in the lower 60s—and therefore less mobile, less able to hear warnings (via cellphone, radio, television, short wave bands and through local sirens), and less able to evacuate easily to higher ground. One resident told us that loading his elderly mother into a car could take more than an hour, and most towns had 20-40 minutes lead time before the arrival of the wave. However, other victims of the disaster who were mobile and heard the warning also perished due to their selflessness or because of decisions that put them at risk. Some caregivers may have perished when they returned to homes to help elderly or infirm family members.

Additional human factors played a role. We heard of neighborhoods such as Sumoubama outside Miyako City, which had regularly practiced evacuation drills, and managed to evacuate all residents before the tsunami’s arrival except for a single individual. Group behavior and pressure to evacuate were critical in some cases: in Kesennuma, members of the Minami shotengai (business owners association) argued that the vast majority of local business owners successfully escaped to high ground, while the three who perished did so because they did not believe that the wave would come and did not want to leave. In other communities, experience with past tsunamis, including the 1896, 1933, and 1960 Chilean tsunami (which reached Japan 15 hours after the initial earthquake in South America) may have lead to inaccurate conclusions about the present tsunami. Specifically, a number of towns and villages erected markers indicating the maximum height from the Chilean disaster, and residents...
may have believed that the wave would not go beyond these artificial boundaries.

Property protection was obviously a powerful motive for some. Victims may have heard the warnings but believed that they had enough time to return to their homes to pick up money (many Japanese residents store large sums of money at home, rather than in savings accounts), invaluable person artifacts, or pets.

**Research Questions.** If technocratic reasons, such as gradient and distance to shelter, account for many deaths, decision-makers should create more shelters in place (as we saw in the city of Rikuzentakata, where three people survived on the top tier of a beach-front cement building built as a vertical evacuation shelter). Alternatively, if human factors are largely responsible, decision makers throughout Japan should sponsor more mandatory evacuation drills, information campaigns, and new procedures to better evacuate the elderly and infirm. Researchers should begin focused interviews with the families, friends, and neighbors of those who perished to create a record of the causes of death of these victims.

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**Emergency Shelter and Housing**

At the time of our visit, there were approximately 730 emergency shelters in the three-prefecture impact region with over 100,000 evacuees (Statistics Bureau, 6/16/11). At the peak, there had been roughly 470,000 evacuees needing shelter (Cabinet Office, 2011). Under the Disaster Relief Act (1947), local governments are responsible for post-disaster care and sheltering with assistance provided by the national government (see Research Committee for Disaster Countermeasure Institutions, 2004). Local governments are expected to pre-designate both shelter facilities and the agency responsible for staffing them. Shelter staffing and logistical support are typically provided by volunteers, nonprofit agencies, the SDF, and shelter residents. The SDF can be involved in delivering water and supplies, providing shower and sanitary facilities, and preparing meals for shelter occupants. The Japanese Red Cross does not take a primary role in shelter operations.

In the communities we visited, the provision of sheltering was dependent on the availability (survival) of local government officials, damage to designated facilities (usually schools) from shaking or flooding, and logistic support. In some cases, predesignated shelter locations were not usable owing to tsunami inundation. Where there was no viable government, local residents established shelters in available structures or under plastic tarps. In the communities we visited, the provision of shelter supplies, food, and water, shower and sanitary facilities, and meal preparation were being handled through mixed combinations of local governments, NGOs, volunteers, the SDF, and shelter residents themselves. Even where shelters were immediately opened after the disaster, it was reported that food and water were not delivered for up to three days because of damage to the communication and transport systems and a lack of fuel for emergency vehicles. Government and nongovernmental supplies eventually arrived, but in many cases supplies were also contributed locally (Figure 9). Shelter residents even developed innovative ways of sharing goods, such as a tool lending box located in one of the shelters (Figure 10).

As would be expected in an event of this kind, sheltering was a mix of planned and emergent activities. For example, in Ishinomaki City, the city government had been working with the local university, Ishinomaki...
Sensyu University, on post-disaster shelter planning. The city and university were scheduled to sign a formal MOU on March 30, 2011. When the earthquake hit, the university opened its facilities for shelters, both to students and to residents of the community. Because the university was not flooded and was surrounded by extensive open space, it became a major coordination and staging area for converging volunteers. It was also able to provide space for the SDF to stage resources and to land helicopters.

A shelter in Ishinomaki City that we visited appeared to be well-run and well-resourced. This school building had been flooded on the first floor and later cleaned up for shelter use. People were living on mats in what had been classrooms on the upper floors (Figure 11). At this shelter, rooms were occupied by residents from the same neighborhood. Staff indicated that residents made their own rules on a room-by-room basis, and that they had daily morning meetings to air their concerns and request resources; we saw a copy of the printed minutes of one meeting. The Japanese Red Cross Society had a presence in the medical clinic area (Figure 12), and we noticed a group of faith-based student volunteers from Tokyo providing some added assistance. Outside the shelter, residents were planting flowers and vegetables in pots and beds. Children’s cubbies were being used to store residents’ possessions. There was a bright library and play area for the 14 children in residence, with numerous books and toys (Figure 13). The children were back in school and thus out of the shelter for much of the day.

Some locations provided facilities for people with health concerns or with physical or developmental disabilities, known as social welfare shelters. Sendai City had an agreement with social welfare service providers to operate 52 shelters for those with special needs, but this is an exceptional case. Other municipalities did not have such agreements; we were told that they did not formally designate social welfare shelters after the earthquake because they believed their facili-
ties would not meet the standard as outlined in pre-disaster planning manuals. Nonetheless, such sheltering operations did emerge, and we heard of health care centers and institutions for the disabled serving as shelters, although not always with adequate supplies.

Many local officials were unaware of the provisions of the Disaster Relief Act covering shelters for people with disabilities. Had the local municipalities officially declared that they were operating social welfare shelters, they would have been eligible for additional resources from both the national and prefectural governments. The majority of those being cared for in social welfare shelters were the frail elderly. Often they had been brought to general-use shelters and identified as needing special services. Officials also decided that the families of disabled persons could accompany them to the special shelters.

However, many people with disabilities did not go to any shelters at all, and therefore officials were unable to assess their needs. Many municipalities have refused to share information on residents with nongovernmental organizations that could have provided services, out of a mistaken belief that such releases would violate a privacy act concerning the protection of personal information (Law No 57, 2003). However, in Minamisoma city, officials did release that information, and in Higashimatsushima, members of groups who work on behalf of disabled persons, such as the Japan Disability Forum, have been allowed to accompany public health nurses on home visits for those with hearing loss. Other cities may be using similar approaches, but at this time it appears that in most affected areas, officials are unaware of the needs of people with physical disabilities, and particularly those with mental health conditions and developmental impairments. Nor does it appear that government officials have attempted to initiate outreach efforts for those populations. In the tsunami-affected parts of Miyagi Prefecture, 53,511 people had been identified as having disabilities, but the Japan Disability Forum has only been able to contact 1,386 of them as of June 17.

Transportation is difficult for persons who are living in shelters, particularly those with disabilities and mobility limitations. Finding transportation will also be challenging for those who move into temporary housing, especially the elderly, who are the focus of many temporary housing programs.

People with places to stay with family or friends, inside or outside the impact region, are not living in shelters. In some respects, these people are probably better off, but they may not have the same access to information and services as those living in shelters, and may be given a lower priority for temporary housing as it becomes available. Others may still be living in their own homes, but without lifeline services and other amenities, and they may be isolated from sources of information, social support, and services. People who remain in the shelters receive different benefit amounts from those who go into temporary housing.

Temporary Housing. The impacts of the tsunami have disrupted the entire fabric of communities: public buildings, hospitals, lifelines, and small and large businesses were simply washed away. Affected prefectures, cities and towns face extremely daunting decisions regarding the restoration of economic activity, redevelopment, and the mitigation of future hazards, and they are expecting the recovery process to last eight to ten years. Because housing recovery cannot be isolated from overall community and regional recovery, residents are facing very hard choices about how best to get on with their lives.

The provision of temporary housing is emerging as a very significant challenge on many levels. The availability of such housing is problematic. Prefectural governments contract with private entities that manufacture housing, but the supply on hand has been insufficient to meet the demand. Ishinomaki City provided financial assistance for people to live in rental housing, but finding housing has been difficult. Some Ishinomaki residents have sought housing in Sendai, which is about 90 minutes away by car or bus. There is concern that these people may later “fall through the cracks” in receiving longer-term rehousing assistance. Moreover, we were told

Figure 14. Damaged communities have little space available for temporary housing and units are placed in wherever space is available (photo: T. Wachtendorf)
that people must locate and secure their own apartments, putting at a disadvantage those without transportation or the ability to negotiate the tight housing environment on their own.

The siting of temporary housing facilities has also been challenging since public space on which to locate them is in short supply. Many of the most devastated areas were located in coastal plains surrounded by steep slopes that are not suitable for building. The preference is clearly to locate temporary housing in areas that already have utility services, but sometimes only two dozen or so units can be grouped together (Figure 14). Additionally, locations suitable in some ways may lack amenities such as shopping, banks, and accessible transportation. Housing may also be located adjacent to areas severely damaged by the tsunami. Despite these constraints, residents have found ways to adjust (Figure 15).

We saw temporary homes constructed from a range of materials. In one temporary house in Noda Village, the inside walls were prone to condensation and served as a conduit for the outside weather. Although most of the temporary houses we viewed were prefabricated units, the news media noted that at least one community in Miyagi Prefecture would receive camper trailers to augment the housing need. Some housing sites had a community center facility situated amongst the units, such as the wheelchair accessible facility in Figure 16.

Ways of determining eligibility and assigning housing vary across communities. Most of the local governments are accepting applications from the affected victims; forms are obtainable in the local government offices, evacuation centers, and on the internet. In Ishinomaki City, the form asked for information about the affected individuals (including whether any are infants, pregnant, or elderly); the status of their former house (including level of damage and ownership); car ownership; and requested housing (including number of bedrooms). In addition, Kesennuma City asked for three pieces of information in the application: i) house was totally damaged, totally burned, or washed away; ii) have no home to live, and iii) have no own financial resources to secure a place to live. Applicants can request an area where they want to live and note their willingness to live in permanent public housing or a hotel or ryokan (Japanese type of hotel) if they were not successful in the housing lottery.

Ideally, housing would be provided in ways that maintain social support networks, but that goal is proving difficult to achieve. Not only does space availability determine the number of units that can be located at a site, but several communities have opted to use lotteries to determine eligibility, or have given priority to the elderly and those with small children. From a research perspective, these diverse decisions and arrangements, which can be seen as natural experiments, should allow for useful comparative studies.

The time limit for receiving temporary assistance is two years, for both renters and those being provided with housing. Article 85 of the Building Standards Act (1945) states that temporary housing can be built in case of emergency (allowing more lenient construction) for up to two years. This period of eligibility suggests an expectation that permanent housing will be ready in two years, but the severity of devastation in the region, and the complexities of recovery, make this highly unlikely. This time limit can be extended, as it was after the Hanshin-Awaji and Niigata Chuetsu earthquakes.

Although it is difficult to generalize about such processes, it appears that the provision of temporary
housing is proceeding at a comparatively slow pace in this disaster. This is an understandable result of all the challenges enumerated previously, but it may also be related to the national government’s need to address the needs of those relocated because of the Fukushima nuclear plant disaster. Fukushima may be “crowding out” other strategic recovery issues at the national level, to the detriment of the survivors of the earthquake and tsunami.

Permanent Housing. According to information provided by our Japanese colleagues, financing for permanent housing can be expected to come from a variety of sources. Those whose homes were destroyed or more than 50% damaged are eligible for a one-time stipend of ¥300,000, which comes through the Life Recovery Assistance Act Concerning Support for Reconstructing Livelihoods of Disaster Victims, enacted October 1998. According to the post-Kobe Victim Support Act, those who need permanent housing can also receive up to ¥3 million from the government. Those who have insurance that covers earthquake and tsunami damage can receive a payout of up to 50% of reconstruction costs, but only a small proportion of people have such insurance. Victims can also borrow money from banks, but then they will end up with two mortgages—one on the original property and one for rebuilding. It is quite likely that many victims will not receive enough assistance to rebuild, in which case, they can avail themselves of whatever public housing may be available, or they can move in with another family.

Another issue has to do with the possible conflict over whether land should be used for temporary housing or for the reconstruction of permanent housing, such as public housing. Such trade-offs became problematic after the Kobe earthquake. In the immediate aftermath,

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount of Damage (approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In JPY</td>
</tr>
<tr>
<td>Buildings (housing, commercial, industrial, machinery, etc.)</td>
<td>10.4 trillion</td>
</tr>
<tr>
<td>Lifeline facilities (water, gas, electricity, communications/broadcasting)</td>
<td>1.3 trillion</td>
</tr>
<tr>
<td>Infrastructure (rivers, roads, ports, wastewater, airports, etc.)</td>
<td>2.2 trillion</td>
</tr>
<tr>
<td>Agriculture, forestry, and fisheries-related (farmland, farming facilities, forests, fisheries-related facilities, etc.)</td>
<td>1.9 trillion</td>
</tr>
<tr>
<td>Other (educational facilities, health and welfare-related facilities, solid waste disposal, other public facilities, etc.)</td>
<td>1.1 trillion</td>
</tr>
<tr>
<td>Total</td>
<td>16.9 trillion</td>
</tr>
</tbody>
</table>

Source: Cabinet Office, June 28, 2011  
Note: ⑴ USD 1 = JPY 80.5

local governments also had to decide whether to use suitable land for temporary housing or for debris staging/sorting/holding. Temporary housing sites may officially take precedence over debris holding sites, but the amount of debris is compelling.

People do need more than housing; they need to be part of a functioning community. Unless the need for coordination across all recovery domains is addressed at the strategic level, outcomes will be poor. There may be economic decline and outmigration from the most severely affected communities, and uneven recovery, similar to what has been documented following the Kobe earthquake and Hurricane Katrina.

Research Questions. Several research questions persist with respect to sheltering, temporary housing, and permanent housing. In many respects, the wide scope of the disaster’s impact makes possible a comparative study of approaches undertaken in different prefectures and communities, whether in terms of decision-making processes, the role of community networks, information sharing, shelter management, or the extent to which risk reduction measures in the recovery effort lead to greater exposure to other hazards.

How space limitations for temporary and long-term housing are contested with will prove important. Finally, much remains to be learned about the differential experiences with service provision to the elderly and persons with disabilities, and the effectiveness of measures for specialized assistance.

Economic Impacts

This event was the most costly disaster in Japan’s modern history, and possibly the most costly natural disaster in the modern world. At an estimated ¥16.9 trillion, or $210 billion (see Table 5), damage in the great East Japan earthquake and tsunami substantially exceeded that in the 1995 Great Hanshin (Kobe) earthquake (¥9.9 trillion in 1995). In comparison, the size of the economy in the tsunami-affected coastal municipalities is about ¥2.1 trillion (measured in terms of gross value added) (The Cabinet Office, May 30, 2011). The annual budget of the Japanese national government is about ¥90 trillion. In addition to physical damage, the catastrophe caused severe losses in terms of economic activity.

This report focuses on economic impacts in the Tohoku region that our team visited; it does not address business disruption in inland areas due to earthquake ground-
shaking, supply-chain disruptions to manufacturing and other sectors, or the consequences of the nuclear power plant crisis (including contaminated farm produce and regional electric power shortages)—all of which are important additional sources of economic distress.

For the most part, the coastal communities devastated by the tsunami were small towns or cities whose economies were heavily dependent on marine-related activities, especially commercial fisheries (both aquaculture and deep-sea fishing) and related processing. Fisheries products from this region include scallops, oysters, abalone, farmed fish, edible seaweed, tuna, and bonito. The regional aquaculture industry had incurred tsunami damage one year previously due to the February 2010 earthquake in Chile, and was just recovering. In contrast to the fisheries towns that predominate on the Iwate coast, Miyagi prefecture’s Ishinomaki and Kesennuma are larger cities with more diversified economies, and Natori’s local economy is closely linked to that of metropolitan Sendai.

**Damage.** The fisheries and aquaculture industry had extensive damage to facilities and equipment, as well as to offshore harvest areas. Of the 14,000 boats and ships in Iwate Prefecture, some 90% were lost. Because the earthquake struck in the mid-afternoon, many fishermen were on shore and unable to quickly launch their boats into the open ocean. Some deep-sea tuna boats were out at sea, but we heard of only a few cases where boats were saved by being quickly sent to sea (for example, fisheries research boats in Kamaishi [Figure 17]). At the time of our visit, many damaged boats remained marooned onshore, awaiting removal by heavy equipment. In some places, we could see damage to structures by boats washed inland by the tsunami.

Aquaculture farmers lost facilities, equipment, stock, and harvesting grounds (Figure 18). In Otsuchi, all the equipment and facilities owned by the local fisheries association was damaged, and there was still no economic activity in this sector three months later. Even in the town of Kuji, which suffered relatively little tsunami damage, the fisheries industry was disrupted, though other economic sectors were reported to be operating normally.

The tsunami also caused severe damage to waterfront infrastructure and industries. Seawalls and breakwaters were destroyed and have yet to be rebuilt, in part awaiting updated hazard assessments, investigation of changes in bathymetry, and decisions on design heights; this has left the harbors they had protected exposed and vulnerable to storms and further tsunamis. Land subsidence caused by the earthquake in many waterfront settings has exacerbated the situation. Port and harbor infrastructure all along the coast was heavily damaged, impeding not only emergency response initially, but also economic recovery subsequently. Figure 19 shows a waterfront fish market in Ishinomaki; only one-tenth of the original 500~600m...
long structure remained after the tsunami.

In some areas such as Natori, low-lying farmland was flooded by seawater due to both tsunami waves and subsidence. In Rikuzentakata, over 70% of agricultural land was inundated. Salt contamination will need to be addressed before the land can be used again for crops. This region also has cattle farming, which uses harbor facilities for transporting feed for the livestock. Some manufacturing facilities nearby were also damaged.

In the small coastal communities, commercial structures were largely lost. In Rikuzentakata’s retail sector, only one convenience store survived. Immediately after the disaster, people were unable to obtain food from commercial sources, so they often sought refuge at shelters that distributed food, even if their homes were habitable. In these communities, virtually no economic activity was observed during our field visit, aside from debris clearance and gas stations, some of which were operating from makeshift facilities (Figure 20). Populations had largely been displaced to shelters and housing away from the waterfront.

Simultaneously, some businesses were reportedly operating from temporary shops and offices.

**Restoration.** While infrastructure services (electricity, water, telecommunications, transportation, natural gas) have been mostly restored in the currently inhabited areas, repairs to tsunami-devastated waterfront infrastructure will require considerably more time. In particular, coastal railways remain damaged, and repairs to ports and harbors are ongoing. Kamaishi Harbor, for example, has been repaired to about 40% capacity and can now be used by medium-sized boats, but not large cargo ships. At the time of our field visit, the harbor was being used temporarily by a steel industry ship (Figure 21) because the steel company’s private port had been destroyed. At the Sendai Airport, which had been inundated by the tsunami, commercial air traffic resumed one month after the disaster. The Tohoku shinkansen (bullet train) resumed service six weeks after the disaster.

Economic activity and employment in the heavily hit towns and sectors remain severely disrupted. In the short term, government subsidies (available for six months after the disaster) and temporary jobs in debris removal are providing some employment for local fishermen and other workers. Some limited fisheries and aquaculture activities have resumed; in Minamisanniku, we learned that, of the various aquaculture stocks in the harbor area, only baby oysters had survived. Fishermen had pooled their nets and stock in a temporary location and began recultivating the oysters. Indeed, mutual aid and sharing of facilities and equipment was a strategy mentioned in many contexts by prefectural government staff, business leaders, and individual fishermen. However, the decentralized ownership of fisheries rights makes such an approach difficult.

The economic outlook for coming months and years remains highly uncertain. In the fisheries sector, besides replacing boats and equipment, underwater debris must be cleared and the seafloor resurveyed before activities can resume (Figure 22). Another obstacle appears to be
bureaucratic delays, for example, the fishermen must wait for the national budget for fisheries subsidies to be approved before funds can be borrowed to replace damaged boats. After fishing and aquaculture activities are resumed, members of the industry are concerned about a potential collapse in demand for their products should radiation contamination be found in local seafood. Even if harmful levels of radiation are not detected, rumors and misperceptions could cause consumers to avoid products from the region.

Financing reconstruction and recovery will be challenging. The City of Natori has estimated that the damage to public facilities alone amounts to 3 times the city’s annual budget. Public infrastructure repairs (roads, ports, debris removal) will be financed by various levels of government, with the national government likely to shoulder much of the burden in the end. The national government had previously adopted its first supplementary budget to cover emergency response costs, but there is currently uncertainty regarding the timing and amount of supplementary funding, including questions about how the national government will raise the funds.

In Japan, no special governmental support is provided for private businesses after disasters. There is relief assistance to groups of businesses, but not individual ones, although legislation has been proposed to give loans as a form of disaster assistance to businesses.

The agriculture and fisheries sectors traditionally receive subsidies from the national government, and most of the recovery costs in the agricultural sector are likely to be covered by national and local government funds. The organizations of these industries (national associations in the case of agriculture, and local co-operatives in the case of fisheries) facilitate the flow of government finance for reconstruction and provide some access to insurance. Relatively few businesses appear to have been covered by insurance.

**Research Questions.** There is a need to investigate and document the full range of economic impacts of the disaster, especially at the local level. Some impacts may be difficult to see: for example, how will environmental impacts affect the recovery of natural resource-dependent economies? This disaster presents a key opportunity to advance understanding of tsunami effects in coastal communities of highly developed, wealthy countries.

Differentials in recovery have already begun to emerge across communities, but what explains them? Potential factors include the extent and nature of physical damage and human loss, the size and geographic isolation of the community, predominant economic sectors, predisaster demographic and economic trends, and post-disaster decision-making. This disaster provides a rare opportunity to make comparisons across communities affected by the same event, particularly regarding strategies and decisions about resource-sharing, debris management, land use, and population resettlement. Can such strategies be planned before a disaster?

As the economic impacts extend far beyond the tsunami-damaged coastal zone, many issues should be studied: the effectiveness of business continuity planning (BCP) in reducing losses; supply-chain disruptions in major manufacturing sectors (including automobiles and plastics); office and business relocation out of the disaster region; impacts of long-term power shortages and energy conservation efforts; the economic effects of the nuclear power plant crisis; reconstruction and recovery finance at the national level; and potential macroeconomic impacts. Although disasters in highly developed economies generally do not cause detectable disturbances to macroeconomic indicators, this may well be an exception due to the magnitude of the reconstruction budgets, the supply-chain disruptions, continuing shortages in energy supply to the nation, the ongoing nuclear power plant crisis, and the context of a relatively weak national economy.

**Debris Management**

As noted above, the areas of Japan that were greatly affected by the quake and tsunami were coastal townships, some of which were industrial fishing communities while others were rural farming communities. The amount of debris for the three damaged prefectures (Iwate, Miyagi and Fukushima) has reached an estimated total of 24 million tons, excluding cars and ships (*Japan Times*, May 2011). This is 1.6 times the amount cre-

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**Figure 23.** Debris pile in Rikuzentakata City reaching several stories tall (photo: T. Norton).

**Figure 24.** Vegetative and miscellaneous sorted debris in Kujū City. (photo: T. Norton).
ated by the 1995 Hanshin earthquake. The average tandem dump truck can legally carry 13 tons on the road in the United States, and it will take approximately 1.7 million truckloads to haul away this debris.

The rapidly growing mountains of debris contain a great diversity of material: concrete, metals, vegetation, vehicles, wood, appliances, fishing equipment, and personal effects (Figures 23 thru 27). In Iwate Prefecture, an estimated 23,742 buildings and some roadways were damaged, resulting in approximately 5.8 million tons of debris. Miyagi Prefecture estimates that it will take two to three years to manage its approximately 16 million tons of debris (700,000 tons of that being in the fishing city of Minamisanriku and 6 million tons in Ishinomaki) (Japan Times, July 2011, and study tour briefings). This amount is 20 times more than the annual waste for the prefecture. In Kesennuma, many ships and buildings were damaged by petroleum fires and the tsunami inundation.

The composition of the debris piles is dependent on the area: since Ofunato is known for its cedar, most of its structures were wood; Kamaishi had a large steel industry.

Debris Management Plan. There is as yet no comprehensive plan to dispose of the overwhelming amount of debris. At first, the Self Defense Forces assisted with the debris removal because the immediate need was search and rescue of possible survivors. Now local municipalities are left to figure out the best way to deal with the piles. Most local governments hope to use contractors, funded by the national government, to perform the remainder of the debris removal and sorting.

Iwate Prefecture plans to complete the cleaning, sorting, and disposal of its disaster debris in the next three years. First, the removal of victims’ bodies and personal mementos will be completed by the end of 2011. The city estimates having debris equal to a hundred years’ worth of its annual waste. The rubble is being separated for recycling at 19 temporary sites. A great majority of the temporary debris sites are located along the coastline, within the tsunami inundation area. For the City of Sendai, debris sorting sites are located inland, near highways. Whether in-
land or along the coast, the temporary debris sites appear to have been selected based on availability and ease of transport to permanent sites or factories (Figures 30-32). Local officials report that the disaster debris will be recycled as much as possible, as is normally the case with waste. Wood material may be recycled as particle strand board, soil recycled for land reclamation, and concrete reused for embankment reinforcement. In Ofunato, kilns will be used to incinerate the rubble into ash that can be mixed with limestone and gypsum to make concrete (Wall Street Journal, 2011). Debris waste is also crushed for transport and recycling (Figure 33).

Deleterious Effects of Debris. Not only is the rubble a visible reminder of the devastation, but it also has a negative impact on the environment (Figures 34 thru 36). It is important

Figure 29. In Miyako City, rubble is dredged from the sea onto large barges.

Figure 30. Temporary debris site along the port in Otsuchi.

Figure 31. Temporary debris site in the parking lot of a former business in Rikuzentakata City.

Figure 32. Temporary debris site just off of the freeway in Miyagi Prefecture.

Figure 33. Rubble crushed into cubes for recycling.

Figure 34. Workers handling construction debris wear masks to protect against dust.

Figure 35. Temporary debris site in rice field of Noda.

Figure 36. Rubble visible in storm retention pond, Minamisanriku.
that the debris waste is managed properly so as not to leave an environmental burden for the next generation (Japan Times, June 2011). At temporary sites and in the sea, rust, salt, and rotted flesh is polluting soil and drinking water, and poisoning marine life. In addition, airborne contaminants, like asbestos in the construction debris of older buildings, can be hazardous to the workers handling removal and disposal. In Fukushima, debris contaminated by radioactivity will be a much more complex issue for the prefecture (Wall Street Journal, 2011; Japan Times, July, 2011).

Research Questions. Will it be possible for municipalities to coordinate efforts and develop a collaborative debris management plan that effectively deals with space management? This plan will need to take into account land ownership and public and private properties. Effective and innovative ways to recycle and reuse viable (uncontaminated) debris should be considered. Can the debris be used for reconstruction and rehabilitation of structures, above-grade elevation of land, or visual memorials?

Recovery Planning

Reconstruction Design Council. On the one-month anniversary of the earthquake and tsunami disaster, Japan’s prime minister established the Reconstruction Design Council in response to the great East Japan earthquake, charging it with the development of a national recovery vision for the Tohoku region by the end of June 2011 (Asahi Shimbun, April 12, 2011). This is the first time such a national planning committee has been established in Japan since the great Kanto earthquake of 1923. The 15-member committee represents academia, business, and religious groups, together with the governors of Miyagi, Iwate, and Fukushima prefectures (Asahi Shimbun, April 11, 2011). In addition to the main committee, a 19-member study group was also established to provide technical support to the main committee. Since their formation, both the main committee and the study group have held a series of meetings, most in the Cabinet Office and not open to the public. However, their work has been uploaded on the Japan Cabinet Office website following each meeting, which has provided public access to the committee’s discussions and ideas.

On June 25th, the committee submitted its national recovery vision, “Toward Reconstruction: Hope Beyond the Disaster,” to the prime minister (Sankei Business, June 25, 2011). The 39-page national recovery vision presents general concepts and strategies for physical recovery in the damaged areas, ideas for job creation and regional economic recovery, needs for resolving the Fukushima nuclear crisis, general concepts and approaches for repositioning Japan in the global economy, and the opportunity to promote a better understanding of recovery processes globally (Asahi Shimbun, April 11, 2011; Reconstruction Design Council, 2011).

Most sections underscore the importance of local governments in leading recovery, with one exception: the national government has the lead in dealing with the nuclear incident and associated recovery. The recovery vision also emphasizes mitigating future disaster impacts.

The first section illustrates reconstruction concepts for tsunami-resilient communities and the vision that holistic community redevelopment approaches will improve community resiliency, enhance evacuation capacity, and create infrastructure redundancy (see Figure 37). Reconstruction concepts for five types of damage areas are also described (see Figure 38):

- **Type 1**: For damaged urban districts in the flatlands near the ocean, the proposed solution is to relocate urban functions to higher lands, while industrial activities, including fisheries, are to be reestablished in the flatlands near the ocean;
- **Type 2**: For urban districts that had both damaged flatlands and undamaged hillside areas, the urban districts are proposed to be integrated with the nonaffected higher land areas. However, since it may be difficult to relocate all uses to higher lands, it is proposed that some urban functions are to be reestablished on artificially raised flatlands near the ocean;
- **Type 3**: For damaged urban districts and villages with limited flatlands, surrounding mountainous areas are to be graded and developed to accommodate the residential areas relocated from the flatland residential areas.

![Figure 37. Reconstruction concept for tsunami-resilient communities (source: Reconstruction Design Council, 2011).](image-url)
Type 4: Damaged flatland plains along the seashores are to be utilized primarily for agricultural activities. Agricultural lands along the seashore that sustained heavy salt damage are to be protected by a giant sea wall with levee-type backup protections located inland. Infrastructure, especially for transportation (highways and bridges), is eligible for inland levee protection. Residential land uses are to be avoided between the sea walls and backup levee-type protections.

Type 5: For areas with damage from liquefaction and other disaster effects (landslides and collapse of artificial lands), rehabilitation and reconstruction of urban infrastructure, residential buildings, and artificial lands will be promoted.

The recovery vision also refers to the adoption of a “special zone” where special land use, finance, and economic measures may be implemented. This could ease some of the various regulations that guide land use and development in the affected areas, including Japan’s city planning act in the urban areas, the act on establishment of agricultural promotion regions, and the forest act. In addition, these “special zone” areas might provide added flexibility in handling land rights issues for lands lost due to subsidence, relocations, or the conversion of agricultural to urban land. Coseismic subsidence affected an estimated land area of 561 square km (216 square miles) in the earthquake, most of it in a narrow, 4-5 km wide zone along the Sanriku coast (Geospatial Information Authority of Japan, 2011).

Prefectural and Local Recovery Planning. Even while the affected region is still visibly immersed in debris removal, sheltering, and construction of temporary housing, recovery and reconstruction planning efforts are underway. Both the prefectural and local governments are establishing reconstruction bureaus to lead the governmental planning and implementation efforts, as well as advisory recovery committees comprised of local government, industry, and community leaders, as well as academics. Neither the reconstruction bureaus nor the recovery committees are required by Japan’s disaster acts, but historical precedence for both of these entities dates back to the 1995 Kobe earthquake.

Iwate Prefecture established its reconstruction bureau on April 25. Its 45-member staff comes from other prefectural agencies, and they will be responsible for managing the entire reconstruction process. One of their current priorities is preparing the prefecture’s basic reconstruction plan and accompanying implementation plan. Of the three most damaged prefectures, both Iwate and Miyagi are aiming to have draft plans completed by August (see Figure 39). Fukushima Prefecture’s planning timeline is slower, reflecting complications and delays resulting from the nuclear incident.
Iwate Prefecture completed its draft basic reconstruction plan on June 9, with a set of planning goals (to protect lives, live with the sea and earth, and create a home town for Iwate/Sanriku) and principles (to promote safety, resilient cities, tsunami mitigation, coast protection facilities, and city facilities) (Iwate Prefecture, 2011). The draft plan also has a set of reconstruction models generally consistent with the national recovery vision, as was suggested. The prefecture aimed to have municipal recovery plans completed in July 2011, with the August time period set for public comments and local meetings. The recovery committee members are being asked to give briefings to local cities and gather local input.

Among the policies and projects proposed in Iwate’s reconstruction plan are the following:

- Completion of a disaster-resisting trunk road network; in 20% of its coastal areas, the new coast highway is not complete yet. The new highway was moved inland and to higher ground just a few years ago and was critical to response, logistics and supply efforts after the earthquake and tsunami;
- Financial support for housing reconstruction in order for residents to rebuild lives;
- Rebuild medical systems with helicopters;
- Policies to move urban functions to higher ground and to keep people together as part of these processes; and,
- Economic and industrial revitalization that includes support to the fishing industry, recreation of small and medium industries, repair of damaged tourist sites, and creation of a new national technology research center in the prefecture.

Iwate Prefecture anticipates eight to nine years (2011–2018) for these policies to be realized, and a significant commitment of national funds to help achieve them. The prefecture is also developing an implementation document by August, after which it plans to submit a request for national funding based on the reconstruction plan. It is also hoped that the Prefectural Assembly will authorize the basic reconstruction plan in September 2011.

Local staff and officials of several communities we visited presented local recovery plans under development (see Table 6). Most are remarkably consistent with the concepts outlined in the national and prefectural plans, and may be an indication of how closely the national Reconstruction Design Council’s work has been followed in these initial months. The consistency may also be a result of the staffing and advisory support in place across the region. Or it may indicate that no city wants to see another move ahead of it in the recovery process.

Prefectures have dispatched support staff to affected cities, and in some instances these staff members are serving in top leadership positions. National ministries are sending staff and experts to work with associated ministries in the prefectures and severely damaged cities and towns. Also, for the first time ever, Japan’s Ministry of Land, Infrastructure, Transport, and Tourism is providing funds to cities and prefectures to hire consultants to assist with damage assessment and recovery planning. Likewise, many academics are serving on prefecture and local recovery committees.

An informal assistance network was started by Hyogo Prefecture, and now includes six prefectures from the Kinki (Kansai) region. It is loosely modeled on the city pairing system that China used after the 2008 Wenchuan earthquake, but the Kinki network is mainly providing technical and staff assistance and does not have any binding financial obligations. Hyogo and Okayama prefectures (and cities within the prefectures) are supporting Miyagi Prefecture and cities within the prefecture; Similar support is coming from Shiga and Kyoto prefectures (and cities) to Fukushima Prefecture (and cities); and Osaka and Wakayama prefectures (and cities) to Iwate Prefecture (and cities). The City of Kobe is supporting the City of Sendai.

Planning, Financing, and Implementation. Japan’s governmental budget cycle starts on April 1 of each year, and thus the March 11 earthquake and tsunami struck after
Table 6. Local Recovery Planning Status (as of June 30, 2011)

<table>
<thead>
<tr>
<th>Prefecture</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miyako</td>
<td>The city established a new recovery promotion bureau in June. It is considering plans for rebuilding fisheries, which are the city’s main industry, and also relocating damaged residential neighborhoods to higher ground (e.g. Type 3). The city will be seeking citizen input to determine the interest level in relocation as well as national government funding for relocations.</td>
</tr>
<tr>
<td>Ofunato</td>
<td>The city established its reconstruction bureau on March 23 and has started its recovery planning process. Disaster management issues are of top concern. A citizen survey has already been conducted, which identified safety as the top priority (42%) for recovery. More resilient seawall reconstruction and subsidence are issues to be addressed. They are awaiting ground surveys and national revisions to the tsunami inundation models. A recovery budget estimate has not been developed yet.</td>
</tr>
<tr>
<td>Otsuchi</td>
<td>A town-level planning effort is underway. The town government plans to select a recovery pattern (i.e. type), collect people’s ideas, and draft the recovery plan. More resilient seawall reconstruction and subsidence are two issues to be addressed.</td>
</tr>
<tr>
<td>Rikuzentakata</td>
<td>Staff have developed reconstruction concepts that include potential relocations, but haven’t engaged with citizens yet. Without budget confirmation from the national government, the city is hesitant to engage with landowners who will want secure sources of buyout funds.</td>
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<tr>
<td>Miyagi Prefecture</td>
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<td>Kesennuma</td>
<td>The city has already started to draft a recovery plan. Port damage, economic recovery, and subsidence are key issues to be addressed. A business association for the port area business street has also developed a draft plan (&quot;K Project for Kesennuma revitalization&quot;) for rebuilding a more resilient and economically diverse business street.</td>
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<td>Minamisanriku</td>
<td>The town has reconstruction concepts to relocate residential neighborhoods to the hills and/or build wider evacuation routes. The town is forming its recovery committee and plan to start surveying residents and conducting meetings to gather input, and aims to have a final draft plan by September. They expect that recovery will take 10 years, with three 3-year phases, focused first on line-life restoration, then addressing recovery needs and potential relocation of homes and city hall, and finally focused on redevelopment and economic development.</td>
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<tr>
<td>Ishinomaki</td>
<td>The city established its recovery committee on May 15. A draft plan was presented to the committee at its first meeting. Three goals of the draft plan are: earthquake and tsunami resilience; an enhanced economy and industry; and better social capital. Reconstruction concepts have been developed but the city is awaiting national revisions to the tsunami inundation models to confirm design heights. The concepts included elevated roadway systems that serve as tsunami barriers, a more resilient energy supply, and more “communal” approaches to rebuilding to promote mutual aid/networks for disaster preparedness. In early May, the city conducted a resident survey that showed residents’ preferences to rebuild their homes in the same location and neighborhoods, and to improve evacuation routes, shelter locations and supplies, and the town’s disaster administration system. The city is still collecting citizen opinions.</td>
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<tr>
<td>Natori</td>
<td>The city has a recovery promotion headquarters, a recovery committee representing many different sectors, and a draft recovery plan – not just to recover but to look to the future of a modern society. In May, some residents of two of the hardest-hit areas of the city proposed resettlement. The city has already held two city-wide citizen meetings: June 5 and July 3. It believes that thinking about the future now will help set the next stage for the city’s recovery. The city hopes to have its proposed plan completed by mid-September.</td>
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</table>

Source: Local governments visited

most of the country’s public agencies had already completed their budgeting for Fiscal Year 2011-2012. Until the FY 2012-2013 budgets are approved, the costs incurred by public agencies in responding to and recovering from the March 11 disaster must be covered through a series of supplementary budget appropriations made by the national government.

The first national supplementary budget, amounting to ¥4.153 trillion (US $51.3 billion) was passed by Japan’s Diet on May 2, 2011. Most of the budget items were mainly to fund emergency response as well as early rehabilitation and reconstruction activities, such as emergency medical assistance, debris removal, and infrastructure repairs (Ministry of Finance, 2011). This funding level is approximately four times the first national supplementary budget approved following the 1995 Kobe earthquake (Yomiuri Shimbun, 2011).

On July 5th, Japan’s National Cabinet approved an outline of the second supplementary budget for approximately ¥2 trillion (US $24.7 billion), aiming for its passage by the end of July (Mainichi Shimbun, 2011). A portion of the second supplementary budget is expected to focus on needs related to the Fukushima nuclear power plant incident and loans for small and medium enterprises (SMEs), as well as individuals, but only half of the total budget has been specified.

The third supplementary budget is expected to be developed soon after the second one is passed, and to contain the main funds for public agency-led recovery and reconstruction. Local and prefectural governments are estimating their reconstruction budget needs as part of their planning efforts. The national Reconstruction Design Council’s vision is also serving an important role in the public recovery funding estimation process, since all the prefectoral and local plans are to be consistent with the national recovery vision. The prefectures will also likely request that the national government support creation of a private reconstruction fund (similar to the ones created after the Kobe and Niigata earthquakes). These funds serve a critical function in allowing donation money to be aggregated and distributed to victims as supplemental support for household recovery.

If national funding is unavailable or insufficient, prefectoral and local governments are concerned that they will be unable to fund relocations, housing reconstruction, or enhanced tsunami mitigation concepts outlined in their draft plans. The recovery planning concepts are comprehensive and will be costly to implement. Given the current economic and fiscal challenges faced by Japan’s national government, it is likely that the prefectures and local governments will have to adjust their visions once the supplementary budgets are approved and allocations are made.

Several public agencies reported hesitancy about engaging in com-
to study what is actually financed and from what sources—public or private.
Similarly, the strengths and weakness of the multilevel, multi-jurisdictional recovery management structure also require further study—of both the formal and informal coordination and support efforts.

The competition for resources during the recovery period allows for study of which emergency measures or early recovery tasks are time-critical and which may impede or facilitate long-term recovery (such as delays in debris removal or selection of sites for temporary housing). How do communities balance the demands for provision of temporary emergency measures with long-term development strategies? The differential application of building moratoria allows us to assess how they can affect the pace of recovery and the outcomes of long-term rebuilding.

It is also important to study how Japan’s traditional strategies for managing tsunami risk (a combination of structural mitigation, land use, and preparedness) are employed in rebuilding communities, and what the key influences are in strategic decisions. In particular, it will be important to study how future risk is addressed in design and construction standards, emergency planning scenarios, and other derivative hazard and risk materials. There will be transferable lessons for consensus-based hazard/risk assessment processes around the world, such as the USGS probabilistic seismic hazard maps and similar state-specific products.

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