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POST-DISASTER CHALLENGES AND OPPORTUNITIES: LESSONS FROM THE 2011 CHRISTCHURCH EARTHQUAKE AND GREAT EASTERN JAPAN EARTHQUAKE AND TSUNAMI

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Abstract

Both the 2011 Christchurch Earthquake and the Great Eastern Japan Earthquake and Tsunami can help practitioners and researchers to further understand the role of information sharing and decision-making in future large-scale post-disaster situations. While both Japan and New Zealand have relatively advanced disaster risk reduction procedures, both cases contain numerous examples where information exchange issues arose, and both challenges and opportunities to learn from the events were encountered. This situation is not unique as reports from past GAR meetings continue to identify challenges around disseminating key information to stakeholders during emergencies and for coordinating post-event reviews. Real events such as the ones cited allow the assessment of current response and recovery practices as well as the identification of gaps in processes. Such studies are important to ensure on-going development and improvements in the Disaster Risk Management field. This paper will help inform policy changes that can be considered in the post 2015 framework for disaster risk reduction.

INTRODUCTION

The 2011 Christchurch Earthquake and Great Eastern Japan Earthquake (GEJE) and Tsunami provide an opportunity to explore how well disaster response agencies and affected communities are able to achieve key elements that are vital to strengthen disaster preparedness, among those: 1) sharing of information across organizational and group boundaries, 2) seeking out lessons that have been learned by others from past disasters and the translation of that experience to current situations; and 3) proactive reflection on their own learning's which are then implemented as improvements to disaster management knowledge and practice.

Past discussion and review of disaster risk reduction highlighted the difficulties of disseminating relevant information to the affected actors during a disaster and problems with coordinating post-event reviews. In this paper, we review existing scientific literature and reports relating to information sharing and decision-making during disaster response and recovery and examine the extent to which best practice was demonstrated in the two cases. The study helps to identify barriers to the implementation of best practice, provides examples where best practice has been implemented and whether or not it was found to be effective, and indicates opportunities for improvement in future disaster events utilizing a comprehensive Risk Reduction Framework. With this backdrop, the two case studies and their cultural diversity highlights key factors to facilitate information dissemination for future disasters, especially during the coordination of global relief assistance. Finally, the paper aims to contribute to a post HFA scenario by analyzing the Priority Action 5 and its future implications.

The paper is divided into four main sections. After this brief introduction, the 2011 disaster events in New Zealand and Japan are presented in terms of the institutional settings in place to manage disasters as well as the response and recovery phases. Following the description of the events, a series of case studies for each disaster is discussed in line with the proposed HFA indicator in order to support a final analysis to improve the exchange of relevant information during disasters and to undertake post-event reviews in the concluding section.

CASE STUDIES: 2011 Christchurch Earthquake and Great Eastern Japan Earthquake and Tsunami

This section presents the two cases previously mentioned. It addresses the complexities in post-disaster response in the light of institutional arrangements and resource limitation (both human and physical). The cases are based in different countries, each with an advanced Disaster Risk Management capability built using different strategies.

2011 Christchurch Earthquake

On September 4th 2010 at 4.35am (NZ standard time), a M_w7.1 Earthquake occurred when the previously unknown Greendale fault ruptured on the Canterbury plains 40 km west of Christchurch, New Zealand. The initial rupture generated a series of aftershocks in the following months culminating with a major M_w 6.3 earthquake on February 22nd 2011 at 12.51pm. With the epicenter of the 22nd February 2011 earthquake located only 10 km south-east of Christchurch city center at a shallow depth of 5 km, the event has claimed the lives of 185 people, generated major damage to infrastructures and became the worst disaster in the history of New Zealand in terms of economic losses (Napier earthquake in 1931 still remains the most deadly event with 256 causalities). This section briefly describes the response protocols implemented by both public and private organizations to manage and restore the numerous infrastructure services affected and the recovery and re-construction planning taking place as soon as the newly created CERA Authority was given full control by the Government.

2011 Christchurch Earthquake Response

The February 22nd 2011 earthquake badly impacted a number of critical systems. Although the tremor generated very high Peak Ground Acceleration (PGA) and the shaking intensity was more than twice the required in the building codes for Christchurch, the overall performance of structures was decisive in protecting life. Moreover, well-prepared organizations supported an efficient response to the event.

Findings of good response practices in the light of organizational arrangements are possible to be drawn by reviewing the impacts on critical infrastructure services and immediate disaster response as follows:

- *Victim Support and Welfare Centers:* immediately after the event at 12:51pm, two main points were set up for those unable to safely return home or to find alternative accommodation. Two victim support centers were set up at Hagley Park near the city center and at Addington Race Course southwest of the city center. Hagley Park welfare center reached capacity as early as the first evening and people seeking shelter were diverted to Addington center (Giovinazzi, Stevenson, Mason & Mitchell *et al.* 2012). By day 4, numerous welfare locations were available to the public, including Cowles Stadium, Burnside High School, Pioneer Recreation and Sport Centre, Rolleston Community Centre and Rangiora Baptist Church. Overall, it was estimated that 450 people were staying overnight in the welfare centers in the first four days while residents were encouraged to go seek support at locations in the outskirts of Christchurch city to reduce pressure on already overloaded critical systems.
- *Water Supply:* the water distribution system was badly affected by the earthquake with only approximately 40% of the city having access to water by Day 4. In addition to a very limited water supply, residents were required to boil water before drinking and cooking. In order to increase fresh water supply, two desalination plants were set up by New Zealand Army at Lyttleton and New Brighton suburbs with capacity to produce 2,000 liters of water per hour at each site as well as distribution at numerous locations was implemented using tankers at specified times of the day.
- *Power:* it is estimated that in the immediate aftermath of the event, 80% of the city did not have access to power. Automatic shutdown systems functioned as designed and there were no reports of fire due to short circuit. Within four days, approximately 80% to 75% of the city had electricity supply recovered with the full restoration of

service expected to take several weeks. Challenges to fully restore the service were due to damaged underground facilities and cable lines (Giovinazzi *et al.* 2011).

- *Transportation (road network):* 32 streets and 13 bridges were closed to the public according to the Christchurch City Council. Closures were due to extensive damage, the placement of a cordon around the central city, and the need to assess structures in order to ensure the safety of users (Brando, Lin, Giovinazzi & Palermo, 2012). A key link between Christchurch CBD and Lyttleton suburb (i.e. the Lyttleton tunnel) was immediately closed to traffic and progressively re-opened. Information of road closures and works were uploaded in a map format through a combined effort between the local and regional councils.
- *Sewage:* extensive damage to the network and long-term recovery time-frame was expected. Being a secondary priority against the recovery of the water supply system, a contingency plan included disposing human waste in holes to be dug at properties' backyards and distributing chemical toilets in the worst affected areas. By day 4, more than 600 chemical toilets were delivered to Christchurch as well as extra shipments due to arrival in the days to follow. As much as possible, the crippled network was used to dispose raw sewage into rivers as an alternative for the lack of chemical toilets and non-functional house toilets.
- *Building Assessment:* in the initial three days, building assessment activities were restricted to the badly affected area of Christchurch Central Business District (CBD). Focus was given to the CBD due to the concentration of high-rise buildings and a lack of human resources to conduct activities (Lin *et al*. 2012). On day 4, a nation-wide coordination task gathered building consent officers, Earthquake Commission (EQC) assessors, professional engineers and specialists from all over New Zealand, which allowed for a large-scale assessment operation to take place. The assessment activity was divided into three task forces: (i) Operation CBD: continuing building assessment at the badly affected central city; (ii) Operation Suburb: 45 teams for house assessment in New Brighton, Darlington, Avonside, Parklands, Queenspark, St Martins, Opawa and Lyttelton. 100 teams for street and house assessment in Sumner, Redcliffs, Woolston, Ferrymead, Hoon Hay, Richmond, St Albans, Fendalton and Merivale suburbs; and (iii) Operation Shops: assessment of malls and shops in order to support restoration of basic product distribution.
- *Fuel:* limited availability for three days following the event due to lack of power to pump it from reservoirs. By day 4, suppliers ensured supply and urged the public to not "panic buy" as stocks were high and the city had regular supply from external regions as the major highways links were not damaged.
- *Food Supply Chain:* the logistics systems for food distribution were not severely impacted, as main road links to access the city were available. However, supermarkets were closed for structural assessment and basic products (e.g. milk and bread) were limited to a restricted number per customer until the business-as-usual supply chain could be restored. Appropriate response actions were observed as the three major food retailers coordinated response and liaised with external suppliers and public.
- *Household Garbage Collection:* emphasis was given to collection of perishable food and general household garbage as lack of power resulted in the expiration of a great

deal of food. Recyclables were not prioritized as they could be stored for future collection without any hazard. By February 26th, the Christchurch City Council estimated that the full service restoration of service would be achieved by March 7th 2011.

- *State Highway Network:* under the management of the New Zealand Transport Agency (NZTA), the major regional links to Christchurch city were not physically damaged, with only a single off-ramp north of the city closed for small repairs. The NZTA cooperated with the City Council to reduce public travel to minimum levels in order to facilitate response activities.
- *Airport Infrastructure:* the airport was initially closed to allow runaway and passenger terminal building assessments. The facility was highly used to support voluntary evacuation and relief operations. The national carrier (Air New Zealand) increased its operation by adding large aircrafts into its fleet (e.g. Boeings 777 and 747 Jumbo Jets) and offering special NZD $50 airfares for flights leaving from and arriving to Christchurch for its domestic network. The official airport authority estimated that over 10,000 people used the airport to leave the city by day 4, which contributed positively to reduce the stress on lifeline systems.
- *Lyttleton Port:* the New Zealand Navy assessed berths and port infrastructure as early as the first day. The main aim was to ensure sea depth and assess machinery to unload cargo for relief operations. Although located close to the earthquake epicenter, facilities were not badly affected allowing for special services such as the arrival of a ship with emergency supplies on February 27th 2011.
- *Public Health System:* General Practice Clinics (GPs) were reduced to 40% of total capacity and the Christchurch Hospital's top floors were partially evacuated due to burst pipes and water leakage in the initial two days (Mitrani-Reiser *et al.*, 2012). Regional and main national hospitals were operating on code red as far as Wellington and Auckland. A consistent improvement was observed on Day 3 with up to 70% of GPs open to business and main hospitals being able to meet the increased demand.
- *Land Assessment:* launched by the EQC, this operation aimed at identifying the extent and characteristics of liquefaction in the city. It quickly became a major effort, as the phenomenon was responsible for structural damage due to differential settlement of buildings.
- *Silt removal: r*esidents were asked to remove silt (liquefied material) to curbside and not on grassed area and footpaths for latter collection. Volunteer support was observed throughout the city, as silt removal was a very laborious operation, with approximately 200,000 tons of material needing to be removed (Villemure *et al.*, 2012).
- *Telecommunication:* both landlines and cell phone networks were overloaded immediately after the earthquake. Authorities and operators urged citizens to reduce usage after reports of trapped people in collapsed buildings using text messages and calling to ask for help. One operator managed to restore its network by day 4, while another operator struggled to recover its towers, which were badly affected.

2011 Christchurch Earthquake Recovery

In order to cope with limited human and physical resources, recovery authorities developed a coordinated recovery plan so high levels of performance could be achieved. After the State of National Emergency was lifted nine weeks following the event, operations were formally shifted from response to recovery. To allow such a transition, the Civil Defense granted full command to a newly created authority, the Canterbury Earthquake Recovery Authority (CERA). Sharing the recovery burden was also the Christchurch City Council (CCC). CERA was to lead the recovery strategy, policy and planning, and the CCC continued to be responsible for regular council-related matters and the coordination of the Central City Plan (Taylor, Chang, Elwood, Seville & Brunsdon, 2012).

In this context, recovery plans were divided into two main levels:

- *Operational:* CCC was responsible for water and waste issues, maintenance of street laterals, portaloos/chemical toilets, roading and traffic management, garbage curbside collection, water conservation and restrictions (with cooperation from the regional council – ECAN) and a rodent management plan. Orion (electricity supplier) was responsible for repairing the power distribution network and individual telecommunication operators had to manage their own networks. CERA was responsible for all individual building inquiries; cordon management including access schemes for business owners to recover documentation and goods, temporary housing, demolitions and debris management, and business restoration (with support from local Councils).
- *Recovery Strategy:* CCC in charge of developing and ensuring a new earthquake-prone building policy, heritage protection, resource consents, CBD business putrescence cleaning; and flood protection. CERA was responsible for coordination and infrastructure planning.

The Canterbury Earthquake Recovery Authority (CERA) and the Reconstruction Planning

A new public authority (namely, Canterbury Earthquake Recovery Authority - CERA) was created and appointed to lead the recovery process.

In general terms, CERA was commissioned with the mission to "restore the social, economic, cultural and environmental well-being of greater Christchurch communities". To do so, the Authority needed to work in collaboration with a number of affected councils (e.g. Christchurch City, Selwyn District, Waimakariri District and Environment Canterbury) (Canterbury Earthquake Recovery Authority – CERA, 2011)

In this context, CERA's roles included: i) providing leadership and coordination for the recovery effort; ii) focus on business recovery so local communities could be restored; and iii) ensure effective and timely rebuilding and keeping the public informed (Canterbury Earthquake Recovery Authority – CERA, 2011).

From a planning perspective, CERA's designations are in line with coordination protocols defined by the Civil Defense Emergency Management Act 2002 and the Coordinated Incident

Management System (CIMS), which are adopted by both national and local authorities when responding to disaster events in New Zealand.

Whilst government agencies were actively involved on the day-to-day recovery operations, public consultation was also open through local community briefings and meetings as well as a major campaign run by the CCC called "Share an Idea". This initiative took place 10 weeks following the February earthquake and generated over 58,000 visits to a website specially designed and had more than 106,000 ideas logged into the system. A final event took place in a gymnasium over a weekend in which about 10,000 residents participated in workshops and/or shared their ideal vision of the city (Taylor, Chang, Elwood, Seville & Brunsdon, 2012). Nonetheless, anecdotal evidences point to the fact that community engagement did not remain one of the strengths of the recovery process following the disaster.

2011 Great Eastern Japan Earthquake and Tsunami

This sub-session discusses the importance of the institutional humanitarian framework for disaster response on relief distribution and community support after the 2011 Tohoku Disasters. The analysis focuses on the existing institutional arrangements in place that were used or adapted in order to promptly respond to the events following the series of disasters experienced after the earthquake and tsunami on March 11th, 2011.

Organizational Disaster Management System in Japan

Effective disaster management is pursued by the National Government by integrating all levels of governance and demanding the involvement of public corporations so the Disaster Countermeasures Basic Act can be properly implemented. The Act was conceived as a response to the 1959 Ise-wan Typhoon. Created in 1961, it targeted a hierarchical approach to manage and mitigate risks as well as improve disaster response. Firstly, the Central Disaster Management Council, chaired by the Prime Minister, was created to coordinate response between the Japanese Red Cross, Public Broadcasters and Semi-public sectors. Secondly, all disaster countermeasures adopted nationally had to be reported by the main government bodies. Finally, the law required the design of a National Disaster Management Plan (divided into national and regional response plans) and "Disaster Prevention Day" was institutionalized in order to develop public awareness nationwide. Overall, the Act was divided into a series of components, such as i) jurisdictions and responsibilities for disaster management; ii) disaster management system; iii) disaster management plan; iv) disaster preparedness; v) disaster emergency response; vi) disaster recovery; vii) financial measures; and, viii) state of emergency.

Of particular interest within the context of this paper is how institutional responsibilities are defined in order to manage disasters. At a macro level, a three tier structure of national, prefectural and municipal organizations is defined (see left hand side of Figure 1). Following this approach, the Central Disaster Management Council is responsible for the formulation and execution of the Basic Disaster Management Plan at the National Level, while the Prefectural and Municipal levels are responsible to formulate and promote individual local disasters management plans. Common to all levels is the requirement to designate administrative organizations (considered as the Cabinet Office and 24 ministries and agencies) and public corporations (i.e., 60 organizations in the fields of transportation, electric power, gas etc., including the Nippon Telegraph and Telephone and the Nippon Broadcasting Corporation for enhanced communication protocols) to support the physical implementation of the plans.

Along with defining key public organizations expected to be involved in disaster response, the Cabinet Office also establishes the role of the Director-General for Disaster Management and a comprehensive management structure under his command (see right hand side of Figure 1). Such a role is of great importance as it ensures that leadership can be exercised during response to disasters.

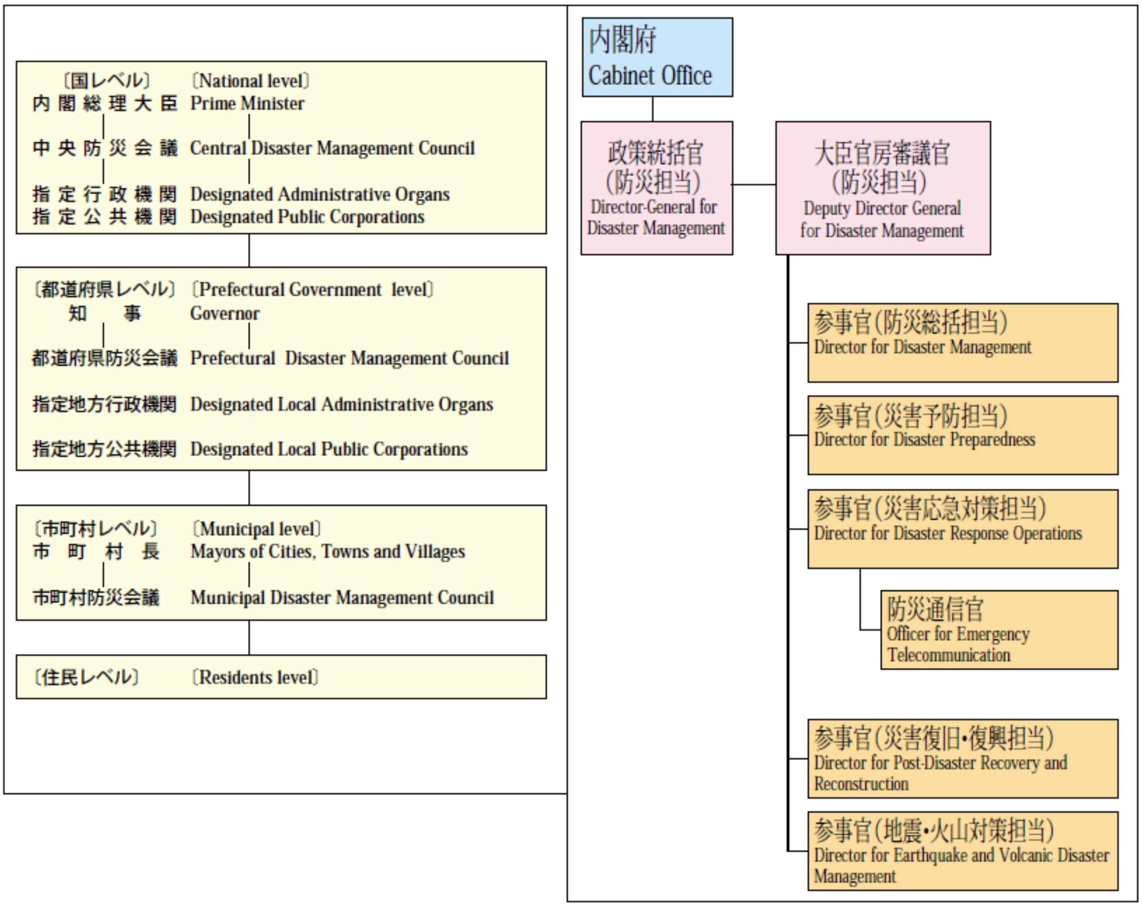

Figure 1 *Disaster management organizations and the Central Government and Cabinet Office structure for Disaster Management (Japan, 2011).*

Institutional Framework for Relief Distribution and Emergency Response: Initial Actions Taken by the Japan Authorities

Mobilization across all levels of the Government was observed in the immediate aftermath of the 2011 GEJE. Considered as a very critical stage for search and rescue, the initial 48 hours after any disaster were dedicated to implement emergency procedures practiced in the country. The effectiveness of monitoring systems was initially confirmed with a tsunami warning being issued by the Japanese Meteorological Agency (JMA) virtually at the same time as the earthquake event occurred. Such quick response, allied with emergency drills practiced all over the country, triggered rapid evacuation of numerous coastal areas avoiding greater loss of lives.

Although communication between the National government in Tokyo and prefectures/municipalities was badly hampered due to the physical collapse of infrastructures and system overload, national media (NHK TV) reports provided a good overview of the situation. A few hours following the Earthquake, the Prime Minister declared that major damage was experienced in vast areas in northern Japan due to the earthquake and subsequent tsunami. Hence, national response plans comprising the hierarchical structure of National, Regional and Local organizations were activated. Within this framework, decision-making ranged from the strategic level at national layers of government to operational at the municipalities. Thus, proper information flows are vital to ensure coordination at all levels of response. The decision to activate the response plans allowed for the mobilization of both human and physical resources throughout the country (e.g. the Japanese Self Defense Force). It also helped to develop strategic plans in the light of a foreseeable humanitarian crisis in affected areas. As an initial response to the event, the Government urged retailers to stock essentials and private logistics operators were required to cooperate.

In spite to the overwhelming size of the event, the response procedures at national level showed to be efficient and implementable in practice. However, the unfolding nuclear crisis on the evening of March 11th stretched Japan's resources and provisional response plans to levels never experienced before. An immediate reaction from the government was to increase response by accepting international support from the USA Army based in Japan, to welcome search and rescue teams from all over the world, and to fully integrate the Japanese Self Defense forces and adapt processes as needed.

Augmentation of response

In face of the unprecedented events, all layers of institutions involved in the response had either to increase their operational capacity (a challenging goal in the face of infrastructure damage and lack of communication) or adapt their plans. With most resources being limited and much of the physical infrastructure damaged in the initial aftermath, organizations were forced to quickly adapt their response plans. In order to cope with the needs, contractual improvisations were put in place through mutual agreements and Memorandums of Understanding. Processes were also redefined in order to cope with the dynamic situation.

The key priorities established for the very immediate response in the context of transport, communication, relief distribution, search & rescue and temporary housing are discussed as follows:

- *Transportation*: restoration of key transport infrastructure to facilitate logistics operations for relief distribution: "...We [Ministry of Land, Infrastructure, Transport and Tourism] have pulled out all resources to restore railways, roads, airports and ports. Thanks to cooperation from all of you and enormous efforts made by all people involved, roughly 80 to 90 percent of them have now [18th March] been restored..." (JOC, 2011b). As a result of such initiatives, all 15 affected major ports along the

Pacific coast of the Tohoku and Kanto regions, all 11 local airports in the northeastern part of the country including the heavily impacted Sendai Airport in Miyagi Prefecture and five vital arterial roads were reopened by March 24th.

- *Communication*: distribution of satellite phones to meet communication needs until physical infrastructure was recovered. Separate provisions for emergency events such as redundant systems proved vital in recovering communication links between all layers of institutions.
- *Relief distribution*: a three-layer system was implemented, having Tokyo as the headquarters to receive donations. Long haul transport would then take supplies to the main unaffected areas to distribution centers, under the Prefecture's management. Final distribution occurred from Refuge Centers (RC) to local communities. Field research conducted shows evidence of the difficulties faced by RCs to receive enough supplies to meet demands in terms of basic relief and food. As discussed in the companion paper, the distribution between the first two layers was possible with no major problems, while the last mile distribution was very difficult. Both public and private operators contributed with know-how and physical resources.
- *Search and Rescue*: mainly executed by the Japanese Self Defense Force with the initial priority focused on providing road access to affected areas and subsequently rescuing survivors.
- *Temporary housing:* the Ministry of Land Infrastructure Transport and Tourism (MLIT) estimated 52,200 temporary housings would be needed to relocate affected people. By May 13th, 10,571 housings were provided and 30,057 by June 8th. Longer time-frames to deliver temporary housing were due to the need to carefully choose locations in order to minimize the risks in case of a secondary tsunami triggered by expected aftershocks in the region.

Considering the importance of transport networks (AELG, 2005), a deeper analysis of the response actions adopted by different organizations involved in the process to restore transportation is further discussed. Focus is given on key transport infra-structures affected in the Tohoku region (i.e., roads, railways, airports and seaports) as well as actions taken in regards to communication in order to coordinate the response.

Complementarily, all ports in the affected region had their operation fully disrupted by the event, with the exception of Aomori port. Intensive work coordinated by the MLIT allowed for ten ports to re-open by March 23rd and 142 out of 373 berths to be fully operational by May 16th.

Key to most disasters, communication issues were targeted by the Government by adopting and supporting a number of different countermeasures as described as follows:

- *Wired communication*: response included restoring power supply and establishing alternative route for a transmission line.
- *Wireless communication*: deployment of mobile base stations and temporary base stations using satellite, making a good use of satellite channels and enlarging areas covered by single bases.

- *Victim support*: to assist victims with communication needs common carriers changed the existing public phone service to a free service and installed additional 3,600 free public phone booths at refugee centers, lent mobile and satellite phones and provided free Internet access at refugee centers, developed web sites to register lost people, prefectures used their own network to create a "cloud service" for businesses and response organizations, etc.

BRIDGING GAPS IN POST DISASTER'S INFORMATION SHARING PROCESSES AND DECISION-MAKING

This section aims at presenting good practice and limitations on the response processes adopted following the disaster events in New Zealand and Japan. Note that such analyses are limited to the scope of the proposed HFA indication PFA4/CI5.

CHRISTCHURCH'S CASE

Decisions following natural disasters needs to be made constantly, rapidly and at the highest levels of confidence. The people making decisions and especially people dependent on their results deserve no less than the best and most current geospatial information at their disposal. Key coordinating agencies, government organizations (both central and local) who own relevant geospatial information, and commercial companies who collect and provide data should focus on how they can individually and as a collaborating team deliver what's needed.

Case Studies

Limited sharing of data post-disaster due to privacy reasons

The accessibility to and sharing of spatial data and the provision of open data for supporting earthquake response efforts has highlighted some key differences between the first months following the Christchurch earthquake and the current (long-term) recovery situation.

In the first months following the earthquake privacy and non-disclosure issues created, in some circumstances, a bottleneck to the sharing of critical data. The negative experience of a privately owned infrastructure provider, who could not access spatial data that could have informed and enhanced their decision making on reconstruction strategies is provided below.

Unsuccessful data sharing affecting the decision making of infrastructure providers

Critical infrastructure services were severely impacted by the Canterbury earthquakes. In order to make rapid and informed decision on alternative repair and reconstruction strategies utilities needed to:

1) Understand the seismic performance of different infrastructure network components and the influence of asset characteristics on performance (e.g. for the water network, understanding whether different pipe materials performed better than others)
2) Assess/predict the expected performance and risk for alternative repair and/or reconstruction strategies in case of further earthquakes.

To achieve the aforementioned goals infrastructure providers needed to have access to data on the seismic demand (e.g. the ground motion, earthquake-induced permanent and transient ground deformation level at the location of the network components), the surface and subsurface conditions (e.g. groundwater level, soil conditions, geomorphology etc.) along with spatial data reporting on the observed damage of other infrastructures, when available (Giovinazzi & Wilson 2012).

Unfortunately many of the aforementioned data could not be made available to the infrastructure providers due to confidentiality issues, so they had to make use of less accurate data and/or alternative sources of data. In particular, maps reporting the land damage to residential areas along with in-situ tests commissioned by the Earthquake Commission (EQC) could not be made available to infrastructure providers since this could breach confidentiality on the damage condition of individual residential properties.

Information on damage to the underground water and sewage network, that could have been used for microzoning purposes (e.g. the location of damage to water pipes could have supported the detection of fault to underground power cable, whose identification is very time consuming and expensive) was not make available. This data was held only by the company managing the water and wastewater network, and by individual researchers, making access by others difficult.

It is worth highlighting that the aforementioned issues that created a bottleneck for the data sharing in Christchurch are identified as common criticalities and issues worldwide for the collection and management of post-earthquake hazard and damage data.

First stage outputs and maps resulting from research projects that were initiated soon after the earthquake event, to investigate the likelihood of future aftershocks and/or expected ground deformation in case of a future event were not made available either.

Successful data sharing enhancing recovery and rebuilding decision-making

Following these negative experiences, very positive changes were seen starting from the short-term recovery phase, with both public and private organizations more willing and able to make their information available with less restrictive conditions. Policies, like New Zealand Government Open Access and Licensing framework (NZGOAL), setting out a series of open licensing and open access principles, were made readily available to mitigate concerns over licensing and liability. New technology was successfully used to provide new and easier ways to deliver geospatial information.

Some success stories are summarized in the following, including: 1) the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) spatial database including all horizontal infrastructure damage & repair data, plus all on-going and planned reconstruction project's; 2) Canterbury Earthquake Recovery Authority "Planning and Community Toolset" online map viewer; 3) Land Information New Zealand (LINZ) program and projects to improve the location-based information in Canterbury.

Stronger Christchurch Infrastructure Rebuild Team's centralized spatial database

The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) is an alliance of privately owned and government organizations established in September 2011 to rebuild the city's damaged street-level civic horizontal infrastructure, which includes water, wastewater, and storm water networks and roads, following the Canterbury earthquakes. The SCIRT team built a centralized spatial database system of all the city's horizontal infrastructure data, planning, cadastral, topographic, and environmental data. SCIRT's Geographical Information system (GIS) can connect to web feature services (such as the "Planning and Community Toolset" described in the following paragraph) from partner rebuild agencies including the Canterbury Earthquake Recovery Authority (CERA) and Christchurch City Council (CCC), providing a powerful online tool for planning, assessing and coordinating various activities across the city. In addition SCIRT has embarked on a "Learning Legacy" project with the goal of sharing the data, reports and stories that encompass the various research projects that are underway at SCIRT, including organizational resilience, build back better, innovations, resourcing the rebuild and metrics of performance. This project is aimed at sharing the learnings from SCIRT with others when SCIRT no longer exists (post 2016).

Further, to integrate data on the damage and repair state of all the civic horizontal infrastructure, the system includes and delivers data and information, on: 1) workflows for work being carried out across the city, for the repair/reconstruction of both horizontal and vertical infrastructures (i.e. buildings); 2) outputs in map format from a Multi Criteria Analysis (MCA) tool that support repair/reconstruction prioritization; 3) integrated asset valuation information. SCIRT's centralized spatial database uses ArcGIS 10 technology and the GIS web applications of the same database were built using the ArcGIS for Server API.

Canterbury Earthquake Recovery Authority "Planning and Community Toolset"

Aiming to inform organizations and the wider community about how Christchurch is changing and how residents, organizations and businesses can plan for these changes, the Canterbury Earthquake Recovery Authority (CERA) set up online map viewer applications referred to as "Planning and Community Toolset".

CERA online viewer contains the layers of information on: 1) land zone status and technical categories; 2) building demolition status; 3) status-quo aerial imagery of the city, and pre-September 2010 earthquake aerial shots; 4) transport and zoning across greater Christchurch; 5) information on schools, community centers, halls, council facilities, libraries, pools and parks. The information comes from a variety of sources and is updated regularly. All layers within the CERA online map viewer contain contextual data and attribute tables and the GIS technology provides query tools for interrogating the data layers.

Land Information New Zealand (LINZ) location-based information to support Canterbury recovery decision-making

Land Information New Zealand (LINZ) embarked on an ambitious program of work aiming to significantly boost the recovery and rebuild in Canterbury by ensuring up to date and easily accessible information and data.

LINZ has been coordinating the repair of Canterbury's positioning and survey control infrastructure. This infrastructure – and the new data being gathered on earth movements – is needed for the design and repair of essential services and assessment of natural hazards in Canterbury. It is also needed for re-establishment of property boundaries so that landowners' interests are protected. LINZ has been implementing a program of work consisting of eight interrelated projects to improve the location-based information in Canterbury and support the Canterbury rebuild (Figure 2), namely:

- 3D Cities: create an interactive 3D computer model recording buildings lost in the recent earthquakes, plans for new structures, places and flows of activities – to be useful in community consultations.
- Canterbury Maps: provide a single online portal for checking maps showing data on air, water, land transport, council services and recreation options across the region.
- Forward Works Spatial Co-ordination: give government agencies and contractors current information on the locations of underground services (water, gas, sewage, telecoms cables, etc), to help them efficiently plan and co-ordinate different professionals and works on site.
- Open Data and API Support: develop smart phone apps for citizens to access useful information services on the move.
- Property Data Management Framework: allow sharing of reliable data about land titles, parcel dimensions, rating units, buildings, addresses and owners.
- Utilities Data Access: enable efficient data sharing about public utilities across Canterbury recovery agencies.
- Geospatial Data Discovery: accelerate online accessibility of location-based information by public agencies, businesses and community groups.
- GIS Interoperability: set up systems for technical experts to exchange their datasets and coordinate their quality standards across a variety of different static structural and dynamic geospatial design, engineering and construction modeling programs.

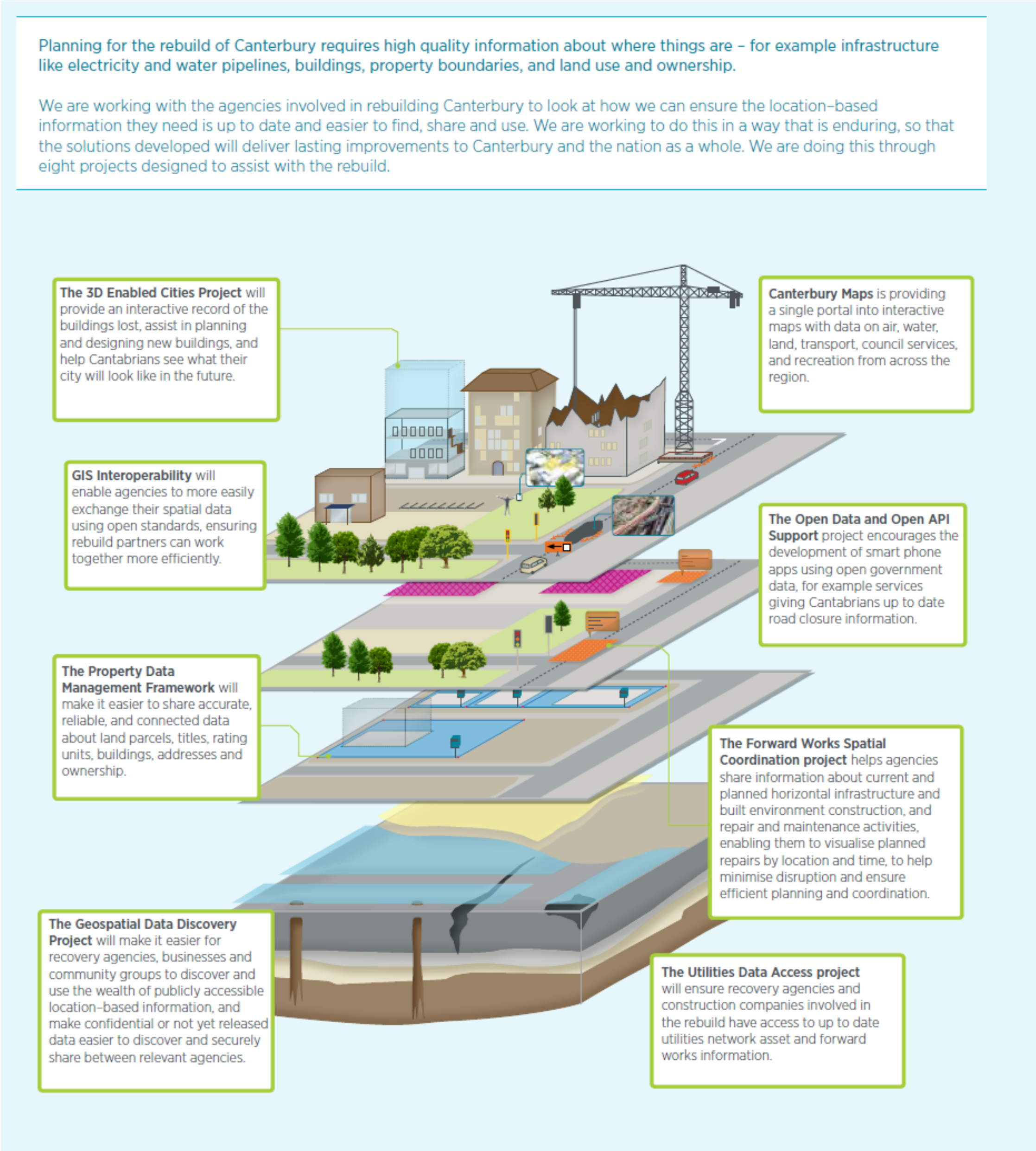

Figure 2 *Canterbury Spatial Data Infrastructure (SDI) Program (Land Information NZ[1])*

Finally, there is also the CEISMIC project at UC to share stories, reports, tools and data with other interested parties through a digital archive.

Assessment of Housing needs: lack of a methodology to collect and collate data

Following the earthquake there was a clear need to understand the temporary housing demand and supply in Canterbury, and at what point during the recovery process temporary housing would be required and made available. In addition to determining the number of people that needed temporary accommodation, there was a significant need for the stakeholders involved in reconstruction planning activities in the Christchurch area to better

[1] http://www.linz.govt.nz/sites/default/files/docs/geospatialoffice/canterburysdiprogrammea3_2013sml.pdf

understand population migration dynamics. Social agencies and local and regional councils from other parts of the country who were attempting to manage or plan for in-migration from affected areas expressed similar needs and concerns.

A wide range of agencies, including CCC, Interagency Housing Group, Canterbury Earthquake Temporary Accommodation Service (CETAS), Canterbury Earthquake Recovery Authority (CERA), Department of Building and Housing (DBH), and Statistics NZ were interested in having a clear understanding on housing needs and population dynamics. The primary questions and concerns raised by the involved stakeholders are summarized in Table 1.

Table 1 *Questions on temporary housing needs and population migration following the Christchurch earthquake*

Temporary Housing Needs and Population Migration: Pressing Questions
What is the current population baseline in Christchurch?
How different is the population baseline from what was expected following the Feb earthquake?
Is migration starting to settle?
How do we assess temporary migration for construction versus business as usual trends?
Will/should temporary accommodation be provided by public or private sector?
Where do people go when they leaves their homes?
Are people planning on coming back?
If they are planning on coming back, when will this be?
Where will temporary accommodation be located and who will go there?
CCC knows supply, but what is the demand?

Unfortunately data on temporary housing needs were never proactively collected. Therefore answers to the aforementioned questions had to be inferred by the processing of multiple databases (e.g. international travel and migration data; information provided by local authorities during an annual consultation round; residential building consents; electoral enrolments; school rolls; tertiary student enrolments; administrative data relating to prison populations and military personnel; tax information, etc.).

Regrettably obtaining and sharing data between the different agencies and amongst decision makers, stakeholders, and researchers was a hurdle to effective collaboration throughout the temporary housing decision-making process (Giovinazzi *et al.* 2012).
As an example, a mathematical model, referred with the name of "Canterbury-Darfield Earthquake Household Displacement Model" was created for CCC to determine the number of people that were likely to be displaced from their homes. The model used EQC data and damage categories to calculate the number of houses that will be needed over time. However EQC data were not made available to CCC in the post-emergency and short-term (more than six months) recovery phase.

As a further example, Statistics NZ were unable to share, due to ethical issues and commercial sensitivity, the information they had obtained from different providers, including mobile phone usage and electricity usage that could have given an indication of population movement and changes following the February earthquake. Statistics NZ itself was unable to obtain insurance data, which would have been useful for understanding the level of housing damage, and enhance predictions of the number of people who either needed to permanently or temporarily leave their homes. Similarly Opus Central Laboratories purchased NZ Post data in order to track mail redirections and gauge migration patterns of the Canterbury population post-earthquake. While they were able to share reports based on this data, they had to ask for permission from NZ Post to share the data itself with others.

These interactions highlight the importance of establishing trust based networks for effective data sharing, transparency, and avoiding duplicate analyses. A lack of data sharing arrangements and trust are issues that create barriers to optimal, efficient and accurate analyses which can inform decisions on a number of issues. Significant efforts have been made following the Canterbury earthquakes to initiate and build greater collaboration between researchers, practitioners, and decision makers post-disaster.

JAPAN'S CASE

This sub-section presents a series of gaps and lessons learned from the 2011 Great Eastern Japan Earthquake in order to bring a general overview of the event. It is expected that the knowledge generated form the analysis conducted under the scope of the Hyogo Framework of Action (Indicator PFA5/CI4) will support proposals for improvements in disaster response, information exchange and post-disasters review.

Case Studies

Response actions taken by the Power Sector and Japanese authorities in the immediate aftermath of the event and lack of measures to incorporate known disaster risks in the Tohoku Region.

The 2011 Great Eastern Japan Earthquake severely overwhelmed the Japanese authorities due to the scale of the event and the diversity of it as well. On one hand, a vast area was affected, which ranged from large urban areas to small villages. Immediately after the disaster, authorities were required to deal with a number of different needs ranging from large demands of relief to the identification/location/evacuation of affected and incommunicable people. On the other hand, the physical damage and the unfolding nuclear crisis in Fukushima Daiichi Nuclear Power Plant added a complexity never before experienced by a single country in a disaster aftermath (Sakurai, 2011).

The so-called triple disaster in Japan (Earthquake, Tsunami and Nuclear Crises) stretched post-disaster response authorities, while the nuclear crises required a considerable effort from different players in order to safely avoid further impact on people nationwide. Indirect impacts from Fukushima reached as far as Tokyo Metropolitan Area where countless residents decided to leave the city momentarily, and water was labeled as inappropriate for child consumption due to elevated levels of radioactive material.

Overall, Japan successfully managed the consequences from the earthquake and some tsunami structural and non-structural measures were vital to reduce the economic damage and human impacts. However, the nuclear crises in Fukushima diverted the attention of response authorities, due to the potential for the crisis to escalate and unfamiliarity in dealing with such events.

An efficient response in the immediate aftermath of the disaster can be observed when compiling the main events following the Earthquake/Tsunami on March 11th (see Table 1) and analyzing the actions adopted by the Japanese authorities. In the specific context of the nuclear crisis, the Japanese Authorities declared an Atomic Power Emergency as early as six hours following the Earthquake and released the first evacuation recommendation. Additionally, as a precautionary measure, other nuclear power plants in the region were also shut down.

Table 1 Chronology of the 2011 Tohoku Disasters

Date / Time[1]	Event Description	Source
11 March 2:46 pm	9.0 Magnitude Earthquake near the East coast of Honshu, 19.9 miles deep.	USGS, 2011
11 March 3:15 pm	7.4 Magnitude aftershock. Buildings still swaying in Tokyo, and mobile networks disrupted.	The Journal (2011)
11 March 4:00 pm	First reports of tsunami waves arriving in Sendai City (Miyagi Prefecture).	The Journal (2011)
11 March 4:00 – 4:30 pm	Over five major aftershocks recorded. Widespread building evacuations in Tokyo. Dozens of fires in the northern prefectures of Fukushima, Sendai, Iwate and Ibaraki. Houses collapsed and landslides in Miyagi Prefecture.	*Numerous sources*
11 March 5:00 pm	Prime Ministry's declares "major damage" due to the Earthquake in northern Japan	The Journal (2011)
11 March 7:46 pm	The government reveals a cooling problem at TEPCO's Fukushima Daiichi nuclear plant.	Reuters (2011)
11 March 8:07 pm	Japan declares Atomic Power Emergency. The government informs that it is a precautionary measure as there were no signs of radioactive leaks.	Kyodo News (2011)
11 March 9:23 pm	2,000 residents near Fukushima Nuclear Plant advised to evacuate.	Kyodo News (2011)
11 March 9:30 pm	4 nuclear power plants close to the earthquake zone are shut down.	CNN (2011)
11 March 10:28 pm	Government urges retailers to secure essentials.	Kyodo News (2011)
12 March Morning	Japanese shipping services stopped.	JOC (2011)
12 March Afternoon	Indefinite interruption of bullet train services to the northern region. Tohoku Expressway closed for assessment.	Reuters (2011)

Date / Time	Event Description	Source
12 March Evening	Full assessment on damage to critical infrastructures expected to take days.	The New York Times (2011)
13 March	Gasoline sales limited in Tokyo. Lights go off on landmarks as electricity concerns spread. Evacuation zone around Fukushima Daiichi complex increased to 20 kms with over 110,000 people relocated. First speculations of catastrophic economic disruptions. Death toll expected to exceed 10,000 people.	*Numerous sources*
14 March	Bank of Japan injects 7 trillion Japanese Yen into money markets. Tokyo residents flee to south Japan as concerns increase in regards to the developing nuclear crises at Fukushima Daiichi.	*Numerous sources*
16 March	Ship lines suspend services for northern ports. Commercial flights diverted from Tokyo. Express carriers restore service to Tokyo to support the mobilization of transport operators for relief operations.	*Numerous sources*
17 March	Estimated that nearly half million people is displaced. Foreigners flee Japan as the nuclear crisis is raised to Level 7.	*Numerous sources*

There are several shortcomings that can be identified in the events leading up to the nuclear crisis. Power plant operator Tokyo Eletric-power Company (TEPCO) had access to risk studies dated from early 2000's. In spite of the knowledge that the coastal area could be affected by a 12m Tsunami wave, the plant's operator did not adopt consistent risk reduction actions. For instance, backup generators were near sea level and tidal/tsunami walls were not up to the required standards of the region's risk profile. In this light, it is possible to point that the availability of information does necessarily leads to action and therefore decision-making processes and responsibilities need to be better defined in the complex process of disaster preparedness.

Following the tsunami, authorities and nuclear specialists were not able to avoid further impacts to both environment and surrounding communities. There were multiple cases of radioactive contaminated water leakage to the Pacific Ocean and observed the difficulties to properly manage the post-disaster nuclear crisis.

In general terms, the combined triple disaster in Japan highlights the need to add further considerations for Nuclear Crisis, especially due to Japan's dependency on nuclear energy as well as extreme difficulties and lack of experience to respond to such events due to its low frequency. In one side of the spectrum, nuclear crises are of rare nature, which does not allow consistent experiences to be compiled. On the other side of the spectrum, such events can generate extreme impacts on vast areas such as to make them unliveable for a very long period of time, combined with long term consequences to exposed population.

Limited pre-disaster planning for maritime and road transport sectors to support relief operations

In the case of large-scale disaster damage like the Tohoku earthquake and tsunami in Japan, it was unimaginable how the intensity could cause widespread damage to the road network. The damages included many road blockages, roads and bridge girders washed away and the damaged nuclear plant, which caused a network disruption of 30 kilometers radius surrounding the plant. On one hand, such a scenario activated the use of ferries to transport personnel and vehicles of the Japan Self Defense Forces (JSDF), fire department and national police agency to the impacted area. On the other hand, plans for relief distribution using either government or private personnel and equipment have shown to be limited in practice.

In regards to the use of maritime mode, several problems were encountered during the operation, which could have been avoided if pre-disaster planning was done. Some of the problems are listed below (Ono, 2013; Suzuki, 2013):

1. There were no pre-designated land-side support for docking ferries, for example ship husbanding agency at each major port and the support of logistics center;
2. Lack of priority sequencing for relief activities by the leadership of the government agency. Mixed and conflicting request from several organizations;
3. Limitation of law to restrict ferries to carry passengers beyond the legal capacity and the restriction of ferries to carry gasoline;
4. Lack of joint drill between JSDF and ferry companies; and
5. Damaged infrastructure for ferry operations like quay and other terminal equipment.

The Civil Protection Law, which was enacted in 2004, considered ferry services as an additional designated public transport in case of warlike emergency situations. This law can also be applied in large-scale disasters like the Tohoku earthquake. During the post-disaster relief operations, it was reported that Mitsui O.S.K Lines (MOL) Ferry Company operated 10 round trips between Tomakomai in Hokkaido and Aomori carrying JSDF members and 1,260 vehicles between 13th – 22nd of March 2011. Other member companies of the Japan Long Distance Ferry Association joined in the effort, which amounted to 53,800 relief forces and 14,600 vehicles over a 3 month period since the disaster hit (MOL, 2013). The private ferry companies should be commended for their effort during the relief operations and some suggestions for government considerations are as follows (Ono, 2013; Suzuki, 2013):

1. Consider mega ferries as one of the key transport modes during large-scale disaster;
2. Government policies should not be biased towards ferry operations, which may affect ferry business continuity;
3. Financial support should be set aside for ferry companies to maintain their fleet for relief operations; and
4. Priority consideration should be given to strengthen maritime transport infrastructure especially for anti-seismic quays and logistics depot.

In the context of road transport, great efforts were mobilized to restore key transport infrastructure to facilitate logistics operations for relief distribution. This priority was observed in practice as all 15 affected major ports along the Pacific coast of the Tohoku and Kanto regions, all 11 local airports in the north-eastern part of the country including the heavily impacted Sendai Airport in Miyagi Prefecture and five vital arterial roads were reopened by March 24th for emergency operations.

Additionally, a three layer system supply chain for relief distribution was implemented having Tokyo as the headquarters to receive donations. Long haul transport would then take place to the main unaffected areas' distribution centers (DCs) under prefecture's management. Final distribution occurred from the DCs to the Refuge Centers (RC) and local communities. Research conducted shows evidences of difficulties faced by RCs to receive enough supplies to meet demands. In general terms, the distribution between the first two layers was possible with no major problems, while the last mile distribution was very difficult. Both public and private operators contributed with know-how and physical resources to alleviate relief distribution limitations while a more sustainable and efficient supply chain process could be designed, adopted and implemented.

Finally, the initial inefficiencies in the relief supply chain, as previously described, implied in lack of capacity to properly process, arrange and distribute large amounts of donations received by the country. The common process of material convergence defined as "the spontaneous flow of supplies, donations and equipment to the disaster area" (Holguín-Veras, Jaller, Van Wassenhove, Pérez, & Wachtendorf, 2012) can be qualified as:

1. High-priority supplies for immediate distribution and consumption;
2. Low-priority supplies that are not immediately needed but could be useful later; and
3. Non priority supplies that are not of any practical use. (Holguín-Veras, Jaller, & Wachtendorf, 2013)

For any countries that have gone through a recent natural disaster or catastrophe and are faced with nationwide chaos and suffering, the problems of unsolicited and unnecessary donations can create additional distress for the survivors. Such items can be classified in the last group of material convergence as defined earlier. These problems and distress are just the kind of challenges encountered by relief effort personnel even till today (Holguín-Veras, 2012). In one observation, a field survey was done to understand the characteristics of Miyagi Prefecture in response to the Tohoku earthquake. The surveyed area had a first class seismic resistant infrastructure and the population had training in disaster evacuation and response. The people had evacuation drills once a year in the past; however, most of the drills do not include humanitarian logistics. It was noted that only one case was present where they held logistics drill between distribution centers but none was found to be associated with the last mile delivery. There was no training and exercise on humanitarian logistics.

During the first week after the disaster occurred, the basic supplies were delivered only by the Self-Defense Force but they did not reach all impacted areas. The affected prefecture projected a sense of unity despite the sufferings and was supported by the business class. There were five logistic companies that approached the authorities to volunteer their services. They delivered supplies for two weeks but were hampered by a week's preparation to set things up. The magnitude and complexity took them by surprise and the widespread sufferings and the last mile delivery posed a huge challenge for them. The concluding remarks from the field survey suggested that the humanitarian logistics challenge in disasters, especially in catastrophic events should not be underestimated. It was also recommended to integrate the private sector with the government organization more efficiently before the disaster to work together for humanitarian logistics effort (Holguín-Veras, 2011b).

Overall, the Japan case highlights that the sole availability of infrastructure (or its quick repair) is not sufficient for an efficient response following a disaster. The examples previously presented show that information sharing and proper communication are of paramount importance either to identify the location of resources internally or externally as well as to transport it to the affected areas according to the required needs (i.e. amounts and types). Note that relief and donations do not often meet the needs of the affected communities due to lack or limited information.

Strong Community Engagement in Post-disaster Situations (Building Social Capital)

Physical capital like reinforcing bridges, buildings and other infrastructures has been the main focus for past disaster mitigation and recovery. However, the argument for stronger social capital focus has gained much attention especially through the experience of the Great East Japan earthquake.

Social capital refers to "the resources available to individuals through their social networks" (Lin, 2008) and encompasses trust and norm of reciprocity. The overall aim of resilient social capital for post-disaster recovery is to show that 'even highly damaged communities with low income and little aid benefit from denser social networks and tighter bonds with relatives, neighbors and extralocal acquaintances' (Aldrich, 2012). The benefits of a resilient social capital include more lives saved through community evacuation, self-organized civilian firefighting corps, community-driven relief distribution etc. (Aldrich, 2011a).

The concept of social capital in relief distribution was introduced in a research effort by Holguin-Veras (2011a). One of the important humanitarian logistics lesson in Haiti was the comparison of Agency-Centric Efforts (ACE) and the Collaborative Aid Networks (CANs). The ACE involved a single agency coordinating the entire humanitarian supply chain while the CANs referred to the distribution of humanitarian efforts to individual, established logistics networks during the time of disaster. In the field study, the ACE met with several major logistical problems. They were unable to do the last-mile delivery.

The CANs highlighted the benefits of the existing collaboration networks. The Evangelical churches' social service with pastors from Dominican and Haiti had fostered peace and development dialogues before the earthquake. They were able to understand the needs of one another in the ground. The Caritas Dominican Republic had a long history of humanitarian work in Haiti and they took the advantage of the established structure to provide assistance.

It was reported that soon after the Great East Japan earthquake, online communities worked together for fundraising drives including sales of books. The oversupply of helpers also led to some Japanese non-profits and religious groups turning down volunteers (Aldrich, 2011b).

Such surge of volunteers occurred in the past Hanshin-Awaji earthquake, which expanded the frameworks of authorized non-profit organizations. In similar situation, the outpouring of help by people both in Japan and abroad in the case of Great East Japan earthquake gained reconsideration on the advantages of such traditional "bonds and solidarity" (Harada, 2012). A strong social capital in the form of stronger community bonds (also known as *Kizuna* in Japanese) tends to reduce unnecessary frictions, which may happen between victims and unfamiliar volunteers (Inagaki, 2013).

Finally, it was reported that the impact of the Tohoku earthquake caused immediate power outage and receiving information from conventional media was only possible through portable radios. Even the internet access with computers was not possible. Alternatives like web-enabled phones and smartphones to access social media sites like Twitter became a source of comfort and lifesaving tool (Kaigo, 2012). Although there were concerns about falsified or unverified information, the simplicity of using Twitter and the function for users to 'follow' a reliable account user can help in immediate response stage following a major disaster.

CONCLUDING REMARKS

The recent disaster events in Japan and New Zealand in 2011 offer the opportunity for researchers and practitioners to review current practice in disasters response and information sharing. Notably, decision making processes are often difficult in nature during the aftermath of such disasters; however, these can be made even more difficult in the light of the limited or inconsistent information.

In both the New Zealand and Japan experiences, information sharing procedures were critical in supporting response and recovery. The two cases provide positive and negative examples where this has been demonstrated. The cases also highlight issues that tend to recur in disasters around the world, where our collective knowledge does not appear to translate into understanding and action, and also where lessons from other countries are not learned and applied in a local context.

It is important however to not feel too dispirited at the recurring nature of many of these issues. As presented in this paper, the New Zealand and Japan cases have demonstrated social and government commitments to both learn from the mistakes of the past and to implement prevention and response strategies for a better future.

For example, on one side of the spectrum, it is heartening to see that in New Zealand, early challenges around the sharing of information during response have been largely rectified during the recovery process. The key to continuous improvement in the way we plan for, respond to and recover from disasters lies in the openness and willingness of our organizations to develop and maintain a culture of ongoing learning. On the other side of the spectrum, the Japan case shows a strong commitment from the private sector (e.g. logistics operators), which avoided a further humanitarian crises by bridging gaps in the government plan for disaster relief as well as lack of capacity to do so, i.e. unavailability of transport equipment.

A critical learning is that resilience in the face of natural disasters has to be developed and sustained in peace time so that it is available when trouble hits. The development of social capital is an important part of that picture. Social capital in the local community can address the "last mile" problem noted in the Japan case. Those relationships fostered between government and private sector players during the day-to-day business can be invaluable network links in addressing both the response and recovery phases of a disaster. Finding better ways of embedding disaster learnings in day-to-day processes and relationships can go a long way to making sure preparedness initiatives and exercises are sustained for the long run.

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