

## Input Paper

Prepared for the Global Assessment Report on Disaster Risk Reduction 2015

### **ADDRESSING INTER-SECTORAL LINKAGES AND INTERDEPENDENCIES**

A study of the past disaster events

**Alice Yan Chang-Richards**

**Erica Seville**

**Suzanne Wilkinson**

**Hlekiwe Kachali**

**Joanne Stevenson**

Resilient Organisations, New Zealand

17 April 2014

## Table of Contents

<b>1. Introduction .....</b>	<b>3</b>
<b>2. Trans-boundary risks between economic sectors.....</b>	<b>4</b>
<b>2.1 Global trends in economic impacts of natural disasters .....</b>	<b>4</b>
2.1.1 The 2010 and 2011 Canterbury earthquakes in New Zealand .....	6
2.1.2 The 2010 and 2011 Queensland floods in Australia.....	7
2.1.3 The 2011 Great East Japan Earthquake and Tsunami in Japan .....	7
2.1.4 The June 2013 Southern Alberta floods in Canada .....	8
2.1.5 The 2008 Wenchuan earthquake in China .....	9
2.1.6 Commentary summary.....	10
<b>2.2 Sector vulnerabilities to natural events .....</b>	<b>10</b>
2.2.1 Agriculture and aquaculture .....	11
2.2.2 Tourism and hospitality .....	12
2.2.3 Retail trades and food services.....	13
2.2.4 Manufacturing .....	15
2.2.5 Commentary summary.....	16
<b>2.3 Challenges faced by the business community in the aftermath .....</b>	<b>16</b>
<b>2.4 Understanding the risks inherent in the dependencies among economic sectors.....</b>	<b>20</b>
<b>3. Conclusions.....</b>	<b>22</b>
<b>References.....</b>	<b>24</b>
Figure 1: Accommodation capacity in Christchurch, source: Statistics New Zealand.....	13
Figure 2: System dynamics interpretation of intersectoral effects after the Canterbury earthquakes of 2010 and 2011 .....	21
Table 1: Summary of economic impacts of recent disasters .....	5
Table 2: Sectors that suffered employment losses after recent natural disasters.....	11
Table 3: Comparison of range of barriers facing businesses in Queensland and Canterbury .....	17
Table 4: Barriers considered by New Orleans businesses to business reopening .....	19

# 1. Introduction

In recent years, economic assets and income potential have seen a rapid increase in exposure to physical hazards. In higher-income countries economic assets and jobs are being created but the risk of losing economic assets and livelihoods from a disaster is increasing. Disasters often disrupt economic activities through the destruction of businesses, homes, communities and infrastructure. Both the disaster itself and the restructuring of economic activities that occurs post-event can fundamentally change the structure of an industry and its relationships with other sectors. The structure of an industry and its connections with other sectors<sup>1</sup> can be fundamentally changed due to the restructuring of economic activities as a consequence of the disaster itself or of the reconstruction (APEC, 2013). The trans-boundary risks inherent in critical industrial sectors therefore have been identified as being major contributors to the vulnerabilities of economy.

The UNISDR 2015 Global Assessment Report seeks to investigate how the economic and productive sectoral policies and plans incorporate the indicators of the Hyogo Framework for Action (HFA) in the management of disaster risk. The UNISDR aims to provide an evidence base to support the design of the successor arrangement of the HFA.

This input paper for the 2015 Global Assessment Report aims to make the case for how public and private agencies can help protect the country's most vulnerable economic activities and productive sectors to reduce the overall impacts of disasters. As part of this discussion, the paper also discusses the trans-boundary nature of risks between critical economic sectors. The paper further explores what drives economic resilience in order to help decision makers to come up with better strategies and practical tools for getting organisations through times of crisis. This paper aims to explore new methods, good practice, policies and regulations regarding how public and private sectors can work together to contribute to risk reduction in critical economic sectors.

The research is based on case studies from Canterbury (New Zealand), Queensland (Australia) and Tohoku (Japan). The case studies, along with other case studies from Sichuan (China) and Southern Alberta (Canada), draw on Resilient Organisations' research report prepared for the APEC Natural Disasters Workforce Project (2013), as well as Resilient Organisations' longitudinal studies in Canterbury following the 2010/11 earthquakes. This research will draw on evidence from the strategies to reduce risk and the vulnerability of economic activities to natural disasters implemented by government and businesses in different countries. The case studies are complemented by a review of literature from the fields of organisational resilience, economic resilience, systems of industrial sectors, economics of natural disasters, social protection and workforce development.

---

<sup>1</sup> In this paper, a group of organisations that operate in the same segment of the economy or share a similar business type are characterised as making up an industry sector.

The questions guiding this research are:

- What are the different sector vulnerabilities to disasters across different countries?
- How do sectors differ in their approach to DRR?
- How do the same sectors in different countries recovery from disasters?
- How do the inter-dependencies between sectors affect economic recovery and business resilience?
- What can be done to reduce sector vulnerability and improve business' DRR activity or awareness?

## **2. Trans-boundary risks between economic sectors**

### **2.1 Global trends in economic impacts of natural disasters**

In higher-income countries economic assets and jobs are vulnerable to disasters, although DRR practices have been applied for many years. In low-income countries, natural disasters still have major impacts on income, employment, regional economic stability and social cohesion. The impacts of different natural disasters in recent years are summaries in Table 1 below, followed by case study discussions of more details of the effect of disasters on businesses.

Table 1: Summary of economic impacts of recent disasters

	Australia	New Zealand	Japan	China	Canada
<b>When</b>	November 2010 to January 2011	4 September 2010 and 22 February 2011	11 March 2011	12 May 2008	June 2013
<b>Event</b>	Floods	Earthquake	Earthquake and tsunami	Earthquake	Floods
<b>Population affected</b>	200,000	460,000	400,000 most directly affected	46 million	100,000 in Southern Alberta
<b>% of regional population</b>	4.4%	81.3%	4.3%	52.5%	2.5%
<b>Number of deaths</b>	36	185	15,883	69,227	4
<b>Damage estimates</b>	AUD 15.7 billion	NZD 40 billion	JPY 16.9 trillion	RMB 845 billion	CAD 500 million
<b>% of national GDP</b>	1%	19%	4%	1% - 3%	0.2%
<b>Industrial structure affected</b>	Coal mining and tourism were most affected. Specific agricultural loss estimates include sugarcane, cotton, grain and banana crops. All of Queensland's 54 coal mines were affected resulting in decreased exports.	Tourism hub, accounting for about 20% of total arrivals in New Zealand. Manufacturing centre although manufacturers outside worst affected areas. Agricultural sector largely unaffected.	Damage to electricity generation capacity, radiation fallout from the meltdown at Fukushima Daiichi Nuclear Plant, several ports severely damaged, damage to automotive and electronic goods factories, agricultural and fishing sectors.	Damage concentrated on manufacturing, agricultural and services sectors. Many factories and businesses in urban areas were either destroyed or closed. Farmland, crops and agricultural facilities were destroyed in large numbers.	The largest contributor to economic loss was the oil and gas industry (extraction & services), which is estimated to have lost CAD 290.5 million in GDP, about 60 per cent of economic output lost by the Alberta economy as a whole.
<b>Initial conditions</b>	Resources sector is core industry. Queensland coal production accounts for 56 per cent of Australia's black coal production and 62 per cent of the country's coal exports. Agriculture is another income generating industry, with sugarcane production alone accounting for 30 per cent of harvest nationwide.	Canterbury was going through modest recovery from recession with positive medium-term outlook, and some spare capacity. There were high agricultural and commodity prices. Agriculture is central to the Canterbury economy, creating seasonal work opportunities in the region.	The Tohoku region was in an upward trend through a slow recovery in individual consumption after the global financial crisis. Agriculture, forestry and fishery were dominant industries in Iwate whereas the tertiary industry and service sectors were primary industries in Miyagi. Manufacturing was strong in Fukushima.	The Province ranks the fifth in land territory. Endowed by natural disasters, Sichuan has a population of 87.5 billion, being one of the most densely populated provinces in China, and one of the most developed provinces in terms of GDP and economic capacity in Southwest China.	Alberta had a rapidly growing manufacturing base. In 2012, investment per capita was CAD 25,348 in Alberta, more than double the Canadian average. The highest economic growth industries include oil sands, agriculture, oil and gas services, construction, machinery, fabricated metals, retail and wholesale trade.

Source: (Parker & Steenkamp, 2012), (Parkatti, 2013) and (APEC, 2013)

### **2.1.1 The 2010 and 2011 Canterbury earthquakes in New Zealand**

A series of large earthquakes struck the Canterbury region of New Zealand in late 2010 and 2011. The two major events were a 7.1 earthquake that hit west of the city of Christchurch<sup>2</sup>, on September 4, 2010 and the deadly 6.3 magnitude earthquake on February 22, 2011. The second quake caused the loss of 185 lives, substantial damage of land and buildings as well as rock fall. The damage was centred largely in Christchurch.

More than 60 per cent of Christchurch's Central Business District (CBD) buildings were severely damaged (CERA, 2012). Another 60 per cent of the 5,000 businesses in the CBD and 50,000 employees were displaced. More than one third of central city businesses were unable to operate, with another third relocating to makeshift premises. Over 150,000 homes (around three quarters of Christchurch's housing stock) sustained some damage from the earthquakes. The total number of individual building, land and contents claims received exceeds 600,000 (Earthquake Commission, 2011).

In terms of infrastructure damage, 1,021 kilometres of roading needed rebuilding, which is around 52 per cent of Christchurch's urban sealed roads. The earthquakes also damaged 51 kilometres of water supply mains and 528 kilometres of the sewer system within the city (CERA, 2012). As more precise information is now becoming available, the latest figures released on 28 April 2013 by the Government suggest that the rebuild with improvements could reach NZD 40 billion with high levels of uncertainty remaining. This damage is about 19 per cent of New Zealand's GDP.

The impacts of the earthquakes were felt not just in Canterbury but across the entire New Zealand economy, with national economic growth estimated to be about 1.5 per cent lower in 2011 than it would have otherwise been. The manufacturing hub in Canterbury escaped significant damage due to its location outside the central city. Tourism in Christchurch has suffered significantly as a result of the earthquakes (Orchiston et al., 2012). As a tourist gateway of the South Island, the city lost a large amount of accommodation capacity and tourist numbers fell considerably following the earthquakes.

Some contributors to organisational and sectoral recovery included public-private initiatives such as the Earthquake Support Subsidy (ESS) (Ministry of Social Development, 2011) where grants were made available to employers for payment of wages in the first six weeks after the earthquakes. Another initiative was the formation of a temporary organisation, Recover Canterbury, to assist small- to medium-sized enterprises (SMEs) survive, revive and thrive after the earthquakes. Recover Canterbury was a venture between the Canterbury Development Corporation (CDC) and the Canterbury Employers' Chamber of Commerce (CECC).

---

<sup>2</sup> Christchurch is Canterbury largest city and the economic hub of New Zealand's South Island.

### **2.1.2 The 2010 and 2011 Queensland floods in Australia**

From November 2010 to early January 2011, significant flooding occurred in Queensland with three quarters of the state declared a disaster zone. The widespread flooding events, followed by Severe Tropical Cyclone Yasi, resulted in the death of 36 people (Queensland Reconstruction Authority, 2012). Over 2,700 houses and 3,500 businesses were affected by floods, forcing about 15,500 people to evacuate.

The floods inflicted significant damages and losses to a vast amount of public infrastructure. There were damages to more than 9,100 kilometres of state road network and approximately 4,700 kilometres of the rail network. Floods also damaged 54 coal mines, 11 ports, 139 national parks and 411 schools (World Bank & Queensland Reconstruction Authority, 2011). The damage to rail and port infrastructure had significantly disrupted the exports of coal and agricultural products to trading countries.

According to the National Australia Bank (2011), the economic impacts of these events were considerable. Queensland's business revenue was reduced by 9.8 per cent and capacity utilisation by 13.8 per cent. Similar disruption occurred across Australia. In the State of New South Wales revenue and capacity utilisation were reduced by 4 per cent and 5 per cent, respectively, and in the State of Victoria by 4 per cent and 3 per cent. Australia's real GDP fell by 0.5 per cent in the March quarter of 2011, but increased by 4.3 per cent over the following year.

As of March 2012, 131,000 insurance claims were reported with an estimated value of AUD 3.8 billion (Insurance Council of Australia, 2012). There were estimated losses of AUD 875 million in primary industries, primarily the sugar, fruit and vegetable sub-sectors. The estimated cost of the disaster in terms of damage and economic impacts was around AUD 15.7 billion or around 1 per cent of the country's GDP (World Bank & Queensland Reconstruction Authority, 2011).

In Queensland also, the public and private sectors came worked together in recovery. In one case, SMEs were helped to build resilient businesses using the Disaster Recovery Toolkit for Business in Australia which contained some of the disaster risk reduction advice offered by the government (CPA Australia, 2009). In another case, the Queensland and Australian governments, set up the Rural Resilience Package in Australia targeted at the primary producer and tourism sectors (Queensland Government, 2011).

### **2.1.3 The 2011 Great East Japan Earthquake and Tsunami in Japan**

The Great East Japan Earthquake with magnitude of 9.0 on the Richter scale occurred on March 11, 2011 about 160 kilometres off the east coast of the island of Honshu, Japan. It was the biggest recorded earthquake ever to hit Japan and the world's fifth largest since 1900 (Japan's Reconstruction Agency, 2012). This earthquake released 8,000 times as much energy as the

magnitude 6.3 earthquake in Christchurch, New Zealand in the previous month (Herod, 2011). The huge tsunami that was generated by the earthquake as well as aftershocks caused tremendous human losses and damage to buildings and infrastructure, particularly in three prefectures of Tohoku: Iwate, Miyagi and Fukushima.

As of May 28, 2012, Japan's Extreme Disaster Management Headquarters listed 15,883 fatalities with an additional 2,676 people still missing. The tsunami caused heavy destruction of roads and highways, the collapse of 126,421 houses, half collapse of 272,028 houses and partial collapse of 740,572 houses. Approximately 4.4 million households in north-eastern Japan lost their electricity and 1.5 million went without water for several days (Herod, 2011). The destruction wrought on the Fukushima Daiichi nuclear power plant forced more than 110,000 people to evacuate due to contamination by radioactive materials.

The US Congressional Research Service estimated that the overall cost of the earthquake and tsunami could be between USD 195 billion and 305 billion, making it the most expensive natural disaster on record (Nanto et al., 2011). A further assessment undertaken by the Japanese Cabinet Office (2011), however, shows that the economic impact of this event was 16.9 trillion yen (approximately USD 207 billion) or around 4 per cent of the country's GDP.

According to APEC (2013), apart from the direct impact from the earthquake and tsunami, the secondary economic effects were considerable, particularly in Japan's exports industries. Due to the disruptions to power supply and global supply chains, there were widespread impacts in the automobile and food manufacturing industries. Two years on, there were 1,164 cases of business bankruptcies<sup>3</sup> and 1,106,000 people were displaced from employment<sup>4</sup>.

Public private collaboration was seen after the 2011 earthquake and tsunami in Japan. Immediately after the disaster events, the Japanese Government established the "Headquarters for Emergency Disaster Measures" headed by the Prime Minister. Under the Headquarters, the "Subsidiary Headquarters for Special Measures to Assist the Lives of Disaster Victims" was established on 20 March 2011. The Conference on the Promotion of Employment Support and Job Creation for the disaster victims was held on 28 March to identify the instruments that could support the disaster victims' work and livelihood (Ministry of Health Labour and Welfare, 2011).

#### **2.1.4 The June 2013 Southern Alberta floods in Canada**

In June 2013, large areas of Southern Alberta experienced a deluge of heavy rainfall that caused disastrous levels of flooding. The floods devastated areas spanning 55,000 square kilometres and affected more than 100,000 people and approximately 10,000 homes (Flood Recovery Task Force, 2013). The scale and impacts of this event resulted in an unprecedented

---

<sup>3</sup> As of May 10, 2013

<sup>4</sup> As of May 8, 2013



State of Provincial Emergency to be declared in Alberta. During the first few days after June 20, 2013, there were 29 local areas in the province declared a state of emergency.

Floods caused significant damage to infrastructure, including roadways, water treatment and waste water treatment facilities, hospitals and schools. Damage to businesses required the evacuation or closure of indoor and outdoor recreation locations (Flood Recovery Task Force, 2013). Economic trends reported as of July 2013 revealed that the flood damage caused short-term supply disruptions, likely hurting economic output in the aftermath (Alberta Treasury Board and Finance, 2013).

The Alberta Government estimated that approximately 5.1 million hours of work were lost during the flooding, resulting in CAD 485 million of lost economic output by the private sector. Factoring in the public sector working losses, the total economic impact of the floods reached approximately CAD 500 million. It represents about 0.2 per cent of Alberta's annual GDP, or about 2.2 per cent of June's GDP (Parkatti, 2013).

APEC (2013) reported that the impacts were not felt evenly across industry sectors. The largest losses were concentrated in the primary resource sectors (with the vast majority in the oil and gas industry) which are estimated to have lost CAD 290.5 million in GDP<sup>5</sup>, or about 60 per cent of economic output lost by the Alberta economy as a whole. The professional, scientific, and technical services industry experienced about one in four employees missing work due to the flooding, losing CAD 61 million, followed by Finance, Insurance, and Real Estate (losing 31 million), and Information, Culture, and Recreation (losing 25 million) (Alberta Government, 2013).

### **2.1.5 The 2008 Wenchuan earthquake in China**

On May 12, 2008, a devastating earthquake measuring 8.0 on the Richter scale hit Wenchuan County in China's Sichuan Province. The earthquake was followed by over 30,000 aftershocks affecting 4,667 towns and large landslides occurred in some places (Ministry of Finance et al., 2012). A population of 46 million in Sichuan, Gansu and Shaanxi provinces was affected by this event (International Recovery Platform, 2010).

The Asian Development Bank (2008) described the Wenchuan earthquake as being a natural disaster that featured the strongest destruction, the widest impact range and the hardest rescue and relief efforts in China since the establishment of the People's Republic of China. Official statistics reported that 69,227 people were killed in this disaster and 17,923 were missing (Ministry of Finance et al., 2012).

---

<sup>5</sup> The figure only covers the last two weeks in June 2013.

Housing was the single greatest component of all losses in terms of economic value and buildings damaged (Chang et al., 2011). Around 7,789,000 housing units collapsed and 24,590,000 were damaged during the earthquake (Paterson et al., 2008). Infrastructure also suffered severe damages. As of September 11, 2008, the State Planning Group (2008) reported that approximately 34,125 kilometres of roads, 1,263 reservoirs, 7,444 schools and 11,028 hospitals were damaged in the earthquake.

The total economic loss in the quake-affected areas was estimated at RMB 845 billion (approximately USD 150 billion) which was around between 1 and 3 per cent of the country's GDP. A number of cities and towns which functioned as major industrial and agricultural bases in the region were among the hardest hit. In urban areas, many factories and businesses were closed due to the damage. More than 1,150,000 farmers lost farmlands and production assets in the earthquake. In total, this disaster had left 372,000 people unemployed and more than 15 million people were forced to evacuate (Ministry of Finance et al., 2012).

### **2.1.6 Commentary summary**

In a comparison of the five natural disasters by their overall losses (as shown in Table 1), the Great East Japan earthquake and tsunami and the Wenchuan earthquake caused many more deaths, destroyed substantially more buildings and together represented a financial loss of more than USD 300 billion. In the case of the Canterbury earthquakes, despite the fact that the event had a lower number of deaths, a smaller number of units damaged, and lower dollar value attributed to total loss, it was the earthquake event that caused serious damage to the national economy.

The disaster events shown in Table 1 have all disproportionately affected the major industries in the region. After the Queensland floods and the Southern Alberta floods, the majority of businesses in resources sectors ceased operations temporarily. In Canterbury, tourism as the major revenue generating sector had experienced the biggest blow from the earthquakes. While the total damage was relatively modest compared to the size of Japan's economy, disruption to nuclear electricity generation from the 2001 earthquake meant severe short-term disruption to industrial production and economic activity across the country.

## **2.2 Sector vulnerabilities to natural events**

Some similarities are evident among the disasters in employment losses (see Table 2). Service industries such as tourism, education, hospitality and the retail trade often experienced the most significant downturn as populations shrank and the number of visitors decreased. In countries like Japan, the U.S. and Indonesia, agriculture and aquaculture tended to be among the worst-hit as well as manufacturing industry. In general, small businesses were more vulnerable to disasters than larger ones. Additionally, as business activities between countries

are increasingly interconnected, international trades like imports and exports were particularly affected by changes in manufacturing productivity.

Table 2: Sectors that suffered employment losses after recent natural disasters

Sectors	U.S.	Indonesia	New Zealand	Chile	Japan	Australia
Tourism			*	*	*	*
Education			*			
Hospitality	*		*	*	*	*
Retailing	*		*	*	*	*
Agriculture		*	*	*	*	*
Aquaculture		*		*	*	
Manufacturing	*		*		*	*

Source: (BLS, 2006), (Nazara & Resosudarmo, 2007), (Parker & Steenkamp, 2012), (United Nations, 2010), (EERI, 2011) and (Venn, 2012)

Understanding how disasters impact different industry sectors can provide lessons that can improve the incorporation of disaster risk reduction into business planning processes to cope with future disasters. Using different sectors as cases for relative differences in DRR across different countries, the next section summarises the major direct and indirect impacts on industry groups.

### 2.2.1 Agriculture and aquaculture

In agriculture and aquaculture industries, major disaster impacts came from damage to facilities, equipment, stock and land. In the Japanese earthquake and tsunami, extensive loss of life occurred for people working in these industries. As most businesses tended to be micro- or family businesses, subsequent disruptions to economic activity in these sectors also incurred income loss and created many jobless households.

In Indonesia, of USD 4.45 billion tsunami damage<sup>6</sup>, 60 per cent was associated with physical damage and 40 per cent was from lost income (Nazara & Resosudarmo, 2007). Around 78 per cent of the total damage was borne by the private sector (World Bank, 2005). While the oil and gas industry in Aceh escaped the tsunami virtually unharmed, the most seriously affected sector

<sup>6</sup> The World Bank's estimate was based on a standard assessment technique developed by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC (United Nations Economic Commission for Latin America and the Caribbean), 2003).

in terms of both the number of casualties and loss of capital was agriculture, particularly fisheries (World Bank, 2005).

According to the Ministry of Marine Affairs and Fisheries, by mid-January 2005 approximately 55,000 fishermen and aquaculture workers were confirmed dead (half of the total number of fishermen in Aceh) and another 14,000 still missing. The Food and Agriculture Organization (FAO) of the United Nations (2005a, 2005b) reported that around 40 to 60 per cent of coastal aquaculture ponds and between 36,000 and 48,000 hectares of brackish-water aquaculture ponds were seriously damaged. 10 per cent of rice fields were also badly affected with soil salinity problems.

In Japan, estimated costs from the Great East Japan Earthquake and Tsunami for agriculture, forestry and fisheries-related industries reached approximately USD 24 billion (EERI, 2011). The regional aquaculture industry in the coastal area of Tohoku suffered significant damage from the tsunami. The fishery food production industry, which employed 0.8 per cent of the overall workforce, accounted for around 30 per cent of the employees in the food production industry. As a consequence of the tsunami, job losses in this sector were significant.

In New Zealand, while the earthquakes created significant stress for agriculture, they had very little impact on revenues (Whitman, 2013). The effects of the earthquakes varied among different farming sectors. Dairy farms were found to be most affected by electricity disruption and structural damage. Mixed and arable farms were most significantly affected by the interruption of water services. Stress caused by these disruptions compounded the challenges of managing day-to-day activities. The importance of the farmers' psychosocial health, however, is likely to be the most critical vulnerability for farming organisations in Canterbury (Whitman et al., 2012).

### **2.2.2 Tourism and hospitality**

The tourism sector often serves as a critical economic driver in many countries. However, its viability heavily relies on a region's attractions and activities as well as associated infrastructures such as transport. Natural disasters can result in significant physical and reputational damage to a region's tourism industry. Recovery of tourism markets, however, tends to take much longer than other sectors as it is closely tied to the timeline of the region's recovery.

In the 2010 Chilean earthquake and tsunami, the tourism industry along the coastline was reported to be amongst the hardest hit, with the port city of Constitucion one of the worst affected. Three giant waves that swept through the town wiped out 80 per cent of its tourism infrastructure such as hotels and restaurants. Most of the people killed in Constitucion were Chilean tourists on Orrego Island at the mouth of the Maule River (United Nations, 2010).

In New Zealand, the earthquakes caused different outcomes on tourism business as a function of their location, business type and direct physical impacts (Orchiston et al., 2012). For

example, prior to the earthquakes the Christchurch CBD was the hub of tourist activity and it bore the brunt of damage caused by the February 2011 earthquake. Many of the attractions and hotels in the central city have been demolished, and others remain either closed or still behind the central city cordon<sup>7</sup>. As of the end 2012, the number of available hotel rooms and beds in backpackers' accommodation in Christchurch had fallen by over two-thirds since the February 2011 earthquake (Figure 1). International visitor numbers to Canterbury have also fallen since February 2011. International guest nights dropped by 6 per cent immediately following the September 2010 earthquake, and then by a further 33 per cent following the February 2011 earthquake and had yet to recover as of the end of 2012 (Parker & Steenkamp, 2012).

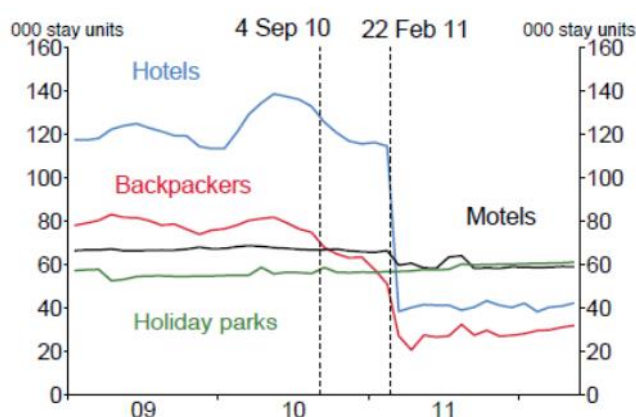


Figure 1: Accommodation capacity in Christchurch, source: Statistics New Zealand

### 2.2.3 Retail trades and food services

Natural disasters can have multiple effects on retailing trade and food services sectors as they are highly reliant on their input and output sources. Disruptions to a retailing supply chain can be prominent especially when the supply of goods and services are natural resources-reliant. Following a disaster, people often decreased spending on “non-essentials” which affected retailing and food services businesses more than others (Stevenson et al., 2012). Reduced numbers of customers in the wake of a disaster can cause more detrimental employment outcomes in these sectors. Resilient Organisations’ longitudinal study of food retailing businesses in Christchurch shows that economies of scale in the retailing sector tend to have different economic and employment effects. Disaster effects to food services businesses are shown in Box 1. This is a comparison of effects to 2 similar food service businesses<sup>8</sup>, FS1 and FS2, after the 22 February 2011 earthquake in Canterbury. At the time of the earthquake FS1

<sup>7</sup> Update on the central city cordon: <http://cera.govt.nz/cbd-rebuild-zone/cordon-map>

<sup>8</sup> For reasons of anonymity and confidentiality, the organisations cannot be named.

was part of a franchise and was based in the Christchurch Central Business District. FS1 had a FTE staff of 6.5. FS2 was a standalone business that had gone through a rebranding exercise 5 years prior to the disaster event. FS2 had a FTE staff of 6.

**Box 1: Comparison of two food services organisations, and economies of scale, in Christchurch**

FS1 and FS 2 were both located in Christchurch's CBD after the 22 February 2011 earthquake. Both organisations cited the large number of employers based in the CBD, as well as other foot traffic, as advantages. Both organisations had a similar number of full-time equivalent staff. However FS1 was part of a franchise and reported receiving assistance from their head office, while FS2 was a standalone business. FS1 and FS2 were also similar in that they were "location specific" businesses, i.e. they had equipment and machinery they could not easily relocate.

Due to the substantial damage caused to the CBD by the 22 February 2011 event, neither FS1 nor FS2 could access their premises. This meant that the two organisations were not trading, had no revenue coming in and could not afford to keep paying their employees. FS1 made arrangements for some of its employees to work in other franchise locations. It was agreed that these employees would return to FS1 when the organisation re-opened. As at November 2011, FS2 had to let their staff go.

This highlights some differences in outcomes between organisations in the same industry where one relied on economies of scale (FS1) and the other (FS2) could not due to differing organisational structures.

Source: (Kachali, 2013)

The industry groups significantly affected by Hurricane Katrina were retail trade (USD 8 billion, or 20.2 per cent), wholesale trade (USD 5.9 billion, or 14.7 per cent) and construction (USD 5.7 billion, or 14.2 per cent) (Experian, 2005). Hurricane Katrina also altered the composition of employment, in hard-hit areas of Mississippi. From 2005 to 2007 in the Gulfport-Biloxi area, reconstruction increased annual employment in the construction sector over 20 per cent, while annual employment in the accommodation and food services sector decreased over 10 per cent due to diminished tourism (Liborio, 2011).

Likewise, the decline in employment in Canterbury following the 2010 and 2011 earthquakes has been most marked in the retail trade, accommodation and food services sectors. According to the New Zealand Reserve Bank, employment in these sectors in Canterbury is estimated to have declined from 54,100 in June 2010 to 41,600 in June 2012. The vast majority of these job

losses was for female workers, explaining the sharp pick-up in female unemployment in the region (Parker & Steenkamp, 2012).

#### **2.2.4 Manufacturing**

In many Asia Pacific Economic Cooperation (APEC) nations, manufacturing industries make an important contribution to their national economies. However, as the manufacturing industry produces goods from raw materials or assembles products from components, it is heavily reliant on other natural resources industries such as agriculture and mining. The Asia-Pacific region in the last decade has become a global production base supplying the domestic and international markets, and some specialist niche markets. The food manufacturing industry in Japan and New Zealand, for instance, produces high-quality products for both their domestic and export markets.

Due to its reliance on primary industries, the impact of natural disasters can have ripple effects on the manufacturing sector across regions. Disasters often strike the confidence of demand sectors, leading to weaker demand and uncertainty over future regional economic conditions. These effects flow through to the manufacturing sector in disaster areas, with output shrinking significantly.

In Japan, the hardest tsunami-hit sector was manufacturing, where the impact of the decline in exports was strongest. In the first few months following the tsunami, some countries in Asia, such as China, Hong Kong, Malaysia, the Philippines, Singapore, South Korea and Taiwan, either banned imports or increased monitoring of goods coming from Japan (Herod, 2011). A particularly dramatic way in which the Great East Japan Earthquake and Tsunami revealed the connectivity of the global economy, however, was through what happened in its automobile industry. For instance, Japanese automobile producers had to slow down their US plants output due to concerns over the availability of parts shipped from Japan. Evidence shows that following the disaster, Japan's overall exports to the US fell by 23 per cent, those to the European Union fell by 11 per cent and Asia-bound shipments declined by 7 per cent (Yuasa, 2011).

In New Zealand, around one-third of manufacturing in the Canterbury region is primary sector manufacturing (e.g. food processing) and nearly all New Zealand's primary sector exporting is done via the manufacturing sector. The performance of agriculture has a significant bearing on the region's manufacturing prosperity. Both sectors were affected by the earthquakes. For instance, Canterbury Spinners yarn manufacturing operation in the hard-hit area of Bromley were forced to make approximately 195 staff redundant due to severe facility damage (Wood, 2011).

The New Zealand Manufacturers and Exporters Association (NZMEA) Survey of Business Conditions in March 2011 reported total sales in the manufacturing and exporting sectors in February 2011 dropped by 13 per cent following the February 2011 earthquake. As the market

confidence remained strong in these sectors, most businesses expected their recovery would compensate for quake-induced production delays by April 2011 (NZMEA, 2011).

### **2.2.5 Commentary summary**

While the effects of natural disasters varied between different commercial sectors, all studied sectors exhibited similar levels of disruption. They have varied vulnerability that exposes them to different effects of disasters. As shown in this paper, the degree of exposure is determined by a number of factors. The post-disaster weakness in economic activities within one sector such as agriculture or tourism can spread to other industries or sub-industries.

The initial impact of disasters was commonly experienced in all studied sectors. They all faced problems such as revenue losses, physical damages, business disruptions, reduced customer-base and decreased demand. As a result, reduced employment sector-wide can be a catastrophe to the local economy, especially in income-generator sectors on which the prosperity of a region or nation relies. The recovery and growth of these sectors in subsequent years, however, depends on how industries overcome their vulnerabilities. Identifying these vulnerability factors within and across sectors and the interdependence between sectors can help businesses and sector groups better plan against different disaster scenarios.

## **2.3 Challenges faced by the business community in the aftermath**

Past events demonstrate that some sectors are more vulnerable than others and the specific risks inherent in the industry structure and their interdependency should be considered, particularly when designing business risk reduction plans and policies. The type of industries that are most affected by a natural disaster, however, depends on the industrial structure of the affected region (Venn, 2012). Business recovery (Zhang et al., 2009), infrastructural restoration (Brunsdon et al., 2004) and central government's role in economic recovery (Kim et al., 2010; Waugh Jr., 2009) at a macroeconomic level (community level), however, play a large part in increasing the overall economic resilience.

Organisations and sectors are also a part of the social and economic fabric of the regions they contribute to and could affect a whole region's social and economic wellbeing if they failed. For example, organisations whose goods and services are necessary for a region's economic growth and by extension its recovery (Popp, 2006). Crises or disasters that at first glance appear localised can have causes as well as outcomes that have a much broader impact. There should be recognition that especially in crises that are regional, the recovery of the organisation, the sector, the community and the region are very closely linked.

To understand the risks facing industry, businesses and communities, Australia and New Zealand had undertaken a number of surveys in the aftermath of the disaster. In Australia, the Chamber of Commerce and Industry Queensland initiated a longitudinal study examining the



impact of the Queensland floods on local businesses. The first survey was undertaken in January 2011 immediately after the flooding events and the second survey was launched six months on from the event.

Similarly, following the 4 September 2010 earthquake, the Resilient Organisations Research Programme and the University of Canterbury launched a longitudinal study to examine the resilience and recovery of organisations within the Canterbury region. After the major event on 22 February 2011, the former Department of Labour (DoL, 2011) created the Canterbury Employer’s Survey to understand the disaster impacts on Canterbury workplaces. Findings from surveys in both Queensland and Canterbury are consistent, revealing a range of barriers commonly facing employers and employees to returning to business as usual.

The survey results in Table 3 show striking resemblance of impacts experienced by business communities in Queensland and Canterbury. Businesses tended to experience short-term disruptions due to physical damages to their premises or assets. A noticeable trend was that as time progressed, the indirect impact of the event on revenue became a major issue preventing a return to business as usual. Businesses in the two regions were facing similar recovery problems such as dealing with insurance pay outs and securing cash flows for recovery.

Table 3: Comparison of range of barriers facing businesses in Queensland and Canterbury

	Queensland (Australia)	Canterbury (New Zealand)
<b>Short-term impacts/barriers</b>	<p><i>Direct impacts</i></p> <ul style="list-style-type: none"> <li>• Short-term closure (53.5%)</li> <li>• Loss of power (39.4%)</li> <li>• Water inundation and/or damage to their business and equipment (30.0%)</li> </ul> <p><i>Indirect impacts</i></p> <ul style="list-style-type: none"> <li>• Reduced sales/profitability (69%)</li> <li>• Affected customers (68.3%)</li> <li>• Employee inability to attend work (48.6%)</li> </ul>	<p><i>Direct impacts</i></p> <ul style="list-style-type: none"> <li>• Damage to or closure of nearby organisations</li> <li>• Damage to or closure of adjacent organisations or buildings</li> <li>• Unable to access site</li> <li>• Electricity supply disruption</li> <li>• Water supply disruption</li> </ul> <p><i>Indirect impacts</i></p> <ul style="list-style-type: none"> <li>• Supply chain disruptions &amp; affected customer base</li> <li>• Impacts on staff wellbeing</li> <li>• Loss of revenue</li> </ul>
<b>Long-term impacts/barriers</b>	<ul style="list-style-type: none"> <li>• Impacted customers, poor consumer confidence, low demand and loss of customers/tourists</li> <li>• Building and insurance delays</li> <li>• Major resource projects continuing to be impacted and the associated flow-on effects</li> <li>• Lack of alternative business sites</li> <li>• Lack of available finance</li> </ul>	<ul style="list-style-type: none"> <li>• Difficulties retaining and attracting staff</li> <li>• Renewing insurance policies, particularly for employers with 50 or more staff</li> <li>• Resolving insurance payments</li> <li>• Cash flow</li> </ul>

Source: (CCIQ, 2011), (Kachali et al., 2010) and (DoL, 2011)

Compounding the immediate impacts was the longer-term effect on consumer confidence in Queensland's retailing and services sectors. The length of time it took for the resources sector to recover had also negatively affected its supporting businesses. In comparison, it seemed that the state of employee wellbeing, together with the capacity of industry to retain employees were major concerns facing Canterbury businesses.

The Canterbury Employer's Survey also captured a range of barriers for employees to returning to employment, including an increase in employees' sick leave, increase in fatigue and increase in stress. Other barriers, as perceived by employees to continuing work were family issues, mental health issues, lack of suitable accommodation and childcare difficulties. Recovery-related issues such as continuing aftershocks, insurance uncertainty, slow recovery, lack of clarity over the recovery process, however, had placed additional stress on workers.

Workplace surveys in Canterbury also highlighted that substantial losses in housing were likely to have an impact on the housing/jobs balance, on the tax base and on services. Given that the habitable housing stock has been greatly reduced in the earthquakes, Christchurch city has found it difficult to ensure the market provides enough affordable housing for displaced residents. Compounding this shortage was the need for housing a large number of additional rebuild workers. It has been an on-going concern which likely constrains labour supply in the region.

For the first six months after the Queensland floods, businesses experienced barriers such as inability to gain site access when recovery started to take place, lack of capital to continue trading, and a reduced customer base due to a perception that Queensland was closed and not open for business (CCIQ, 2011).

Similarly, six months on from the February 2011 earthquake in New Zealand, businesses reported difficulties in reopening including damage to premises, financial problems, insurance renewals and staff retention and recruitment (DoL, 2011). The most prominent issues still facing businesses by the end of 2012 were around cash flow, building relocation issues, retaining customers and dealing with insurance (Hatton et al., 2012).

In Australia, more than half of businesses affected by the floods were able to reopen within five days, while 17 per cent remained closed for three weeks or longer. More than 20 per cent of businesses surveyed by the National Australia Bank (2011) reported that it would take up to one month to recover and 22 per cent stated it would take one month or longer. The survey conducted by the Chamber of Commerce and Industry Queensland (2011) shows that among the types of assistance needed by businesses for restoring their capacity, financial assistance with cash flow was ranked as the highest priority.

In the case of post-Hurricane Katrina, Lam et al. (2009) reported that 25 per cent of businesses in New Orleans had reopened within four months, 38 per cent within ten months and 66 per

cent within two years of the storm. The barriers to business reopening varied over their recovery timeframe (Kim et al.). The reported barriers and their timeline in Table 4, however, are consistent with issues voiced by the business communities in Canterbury following the earthquakes. Damage to business premises, coupled with financial constraints can affect the process of business recovery. As shown in Table 4, those two issues were reported as being prominent for businesses that were unable to reopen two years after the Hurricane Katrina.

Table 4: Barriers considered by New Orleans businesses to business reopening (Lam et al., 2009)

Barriers to business reopening	6 weeks	4 months	10 months	2 years
Damage to premises	*			*
Damage to social and physical infrastructure	*		*	
Affected supplies and customers	*	*		
Cash flow/financial constraints	*			*
Uncertainty about the ability of flood levees to protect the city		*		
Difficulty recruiting new staff			*	

It has to be mentioned that there is little information on the role insurance plays in business recovery from adverse circumstances such as natural disasters. The work undertaken by Resilient Organisations looking at the role of insurance in organisational recovery following the 2010 and 2011 earthquakes (Brown et al., 2013) shows that New Zealand has a relatively high insurance penetration but underinsurance was reported as an issue following the earthquakes. Businesses were frustrated by the slowness of claims settlements.

A number of significant factors complicated the claims process and contributed to the delays in New Zealand, including: the number of damaging earthquakes, the number of claims, the extent of damage, open-ended policy wording, resource constraints, regulatory changes and technical challenges (Brown et al., 2013). Australia, however, had similar experiences with insurance following the Queensland floods (Venn, 2012). Delays in insurance pay outs mean businesses, particularly small businesses, take longer to get re-established and thus may not bring staff back to work.

As evidenced in Australia, New Zealand and the U.S., beyond the ability to temporarily relocate businesses, the capacity to garner the financial and psychological resources to revive business operations is a big challenge for all types of businesses, particularly for small and medium enterprises (SMEs). Additionally, in many cases, businesses carry a social responsibility to look after their employees. Therefore, understanding employees’ needs – what caused their low productivity or inability to attend work - following a natural disaster is critical for businesses to provide targeted support that can reduce the effects of business disruptions.

## **2.4 Understanding the risks inherent in the dependencies among economic sectors**

The effects of disaster are different for different industry sectors. As there are interactions and dependencies between organisations in the same or different sectors, it follows that there are interactions and dependencies between sectors also. Different sectors work with and rely on each other to exchange inputs (e.g. raw materials, information) that are then transformed into goods and services for commerce (Lambert & Cooper, 2000). It is therefore important for sectors to understand how they could be affected by other sectors.

Analysis of the interdependence of sectors reveals how sectors are affected by disaster, how they interact with each other in disaster and how they affect each other's recovery. The microeconomic processes that guide the recovery of organisations and the meso- and macroeconomic processes that dictate the cost and pace of reconstruction and community recovery are both driven by a complex network of interactions. Similarly, disruptions to crucial intermediate sectors may lead to multiplier effects on businesses that are interconnected following a disaster. For example, the cost of resources required for reconstruction can be much higher than the pre-disaster price, as a consequence of disaster-related supply disruptions (Jayasuriya & McCawley, 2008; Le Masurier & Wilkinson, 2006) and scarcity of resources (Chang, Wilkinson, Seville, & Potangaroa, 2012). Changes in prices of construction resources can cause recovery program cost overruns (Koria, 2009; Steinberg, 2007) and prolong recovery schedules (Boen, 2008).

An example of such sectoral interdependencies and their effects was evident after the Canterbury earthquakes. Using sectoral data collected in a study after the Canterbury earthquakes (Kachali, 2013), Figure 2 captures how different sectors interacted with each other after the earthquakes<sup>9</sup>. Some sectors were highly interdependent on each other, for instance between Trucking and Fast Moving Consumer Goods (FMCG) and also between Critical Infrastructure and the Christchurch Central Business District (CBD).

For the purposes of illustration, these sectoral interdependencies are characterised in Figure 2 by positive feedback loops, R1 and R2. Positive feedback results when a change builds on itself and the result is amplified. If unchecked, positive feedback loops can continue to grow exponentially. In this case Trucking affects FMCG which affects Trucking which affects FMCG and so on.

---

<sup>9</sup> For reasons of space, it is not possible to fully discuss the effects all the sectors had on one another.

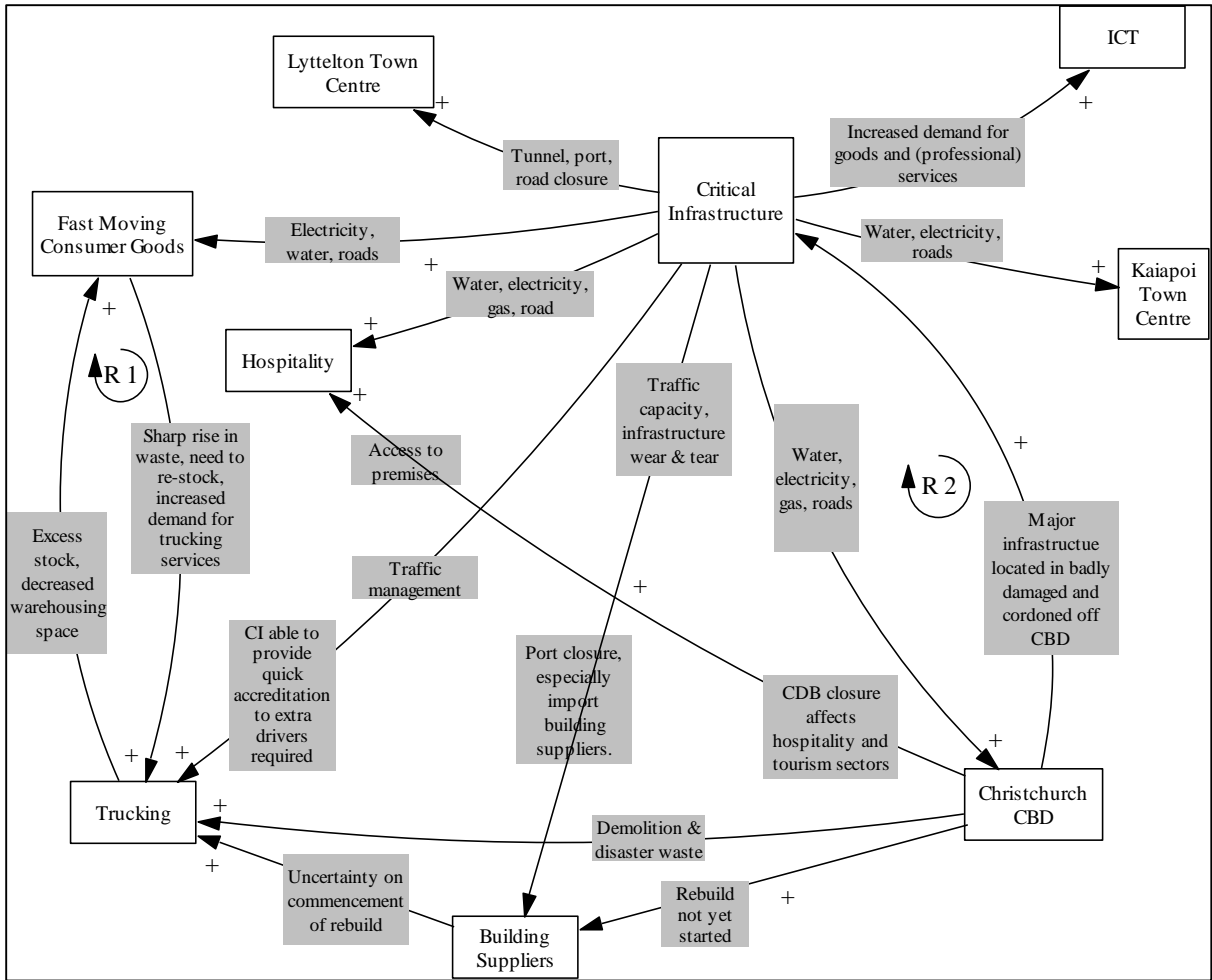


Figure 2: System dynamics interpretation of intersectoral effects after the Canterbury earthquakes of 2010 and 2011

For the positive feedback loop R1 between the Trucking and FMCG sectors, breaking the loop required the re-establishment of demand/supply equilibrium between the two sectors. This equilibrium was also dependent on other components such as FMCG organisations requiring trucking services to take away excess waste caused by disruption to electricity and water as well as their being unable to receive goods before cleaning up after stock breakage due to broken shelving. On the other hand, the Trucking organisations found themselves with the problem of not enough warehousing due to earthquake damage, excess pre-earthquake stock they could not deliver and, interestingly, an increase in demand for goods, much of which they could not order or receive because of space constraints.

The positive feedback loop R2, between Critical Infrastructure and the Christchurch CBD illustrates the consequences when infrastructure providers have major assets in built-up areas with a lot of unreinforced masonry buildings that were badly damaged by the earthquakes and subsequently condemned for demolition. Additionally, organisations in the CBD area, but not

within the cordon, were subjected to slightly longer service interruption times as they waited for Critical Infrastructure providers to gain access to the cordoned off area and make repairs.

The manifestation of loops R1 and R2 shows that aside from the preparation done by individual organisations, ecological factors should also be considered in recovery from disaster. For instance, seismically reinforcing critical infrastructure while still situating it in areas where buildings are vulnerable to earthquakes is only one part of the solution. Networks should also be designed with the environment they interact with in mind: first to minimise damage and second to enable quick restoration.

### **3. Conclusions**

This paper has shown that natural events directly impact on labour-intensive sectors, such as manufacturing, services and agriculture industries. Loss of production assets, facilities and closure of workplaces can lead to significant revenue losses and job displacement of employees in these sectors. A disaster can bring about fluctuations in the economic cycle and cause structural adjustment in different industry sectors. Sectors that are less prepared or sectors that are vulnerable to economic shocks and disturbances suffer the most. There is a need to understand key linkages and interdependencies between sectors, sectorial responses and to design policy responses to improve disaster risk reduction in those sectors.

Building on ongoing studies undertaken by Resilient Organisations, the cases written for this paper provide an understanding of trans-boundary nature of risks between critical economic sectors in New Zealand, Australia and Japan that have had the impact on a national economy, sector or business of ineffective management of disaster risk. The paper reports on the economic and productive sectoral policies and plans that have been implemented to reduce the vulnerability of economic activities in the case study countries.

A number of surveys of employers in disaster-affected areas highlighted some of the barriers commonly faced by businesses. Understanding these barriers and the time they are likely to occur can help both policy makers and business communities themselves better embrace disaster risk reduction elements in their preparation against the varied scenarios.

Business continuity plans and public resources for rebuilding business resilience are critical for businesses to prepare for and recover from disasters. Case studies show that it is also in the interests of organisations to have prior readiness and staff-support measures that provide benefits to organisations once a disaster happens. A standardised business continuity planning tool (e.g. Queensland's Disaster Recovery Toolkit for Business), can be a vehicle through which disaster risk reduction elements can be included. Other resources, such as those developed by

Resilient Organisations<sup>10</sup>, are also available to support organisations to both evaluate and improve their resilience (e.g. (Lee et al., 2013; McManus et al., 2008; Whitman et al., 2013)).

A key accomplishment in implementing the Hyogo Framework for Action (HFA) is the increase in the number of countries establishing a multi-sectoral National Platform<sup>11</sup> to engage more stakeholders in disaster risk reduction (UN/ISDR, 2013).

The cases included in this input paper uncover several drivers that enhance the adoption of disaster risk reduction in private sectors. These include:

- Barriers and risks that are faced by businesses are well captured by a number of business surveys in the aftermath of natural disasters. Achieving a sound understanding of 'what risks might be' and 'how the impacts of those risks can be reduced' is fundamental to effective DRR planning and intervention to support resilience building of organisations.
- The capability of financial, technical and specialist support, especially support for targeted vulnerable sectors such as SMEs is critical to the success of DRR incorporation activities. Financial incentives and business mentoring services of 'know how' played an important role in helping businesses to consider risk in their recovery decisions.
- An organisation sits within a wider system and resilience is required at all levels of this system: organisational, community and personal. Therefore, a systems approach is needed in considering the trans-boundary risks inherent in the interdependency of business sectors.
- The planning and development of business resilience toolkits should be developed in order to integrate both available resources and pre-existing mechanisms.
- In order to capitalise on opportunities for adopting disaster risk reduction in business practice, it is important that the concept of organisational resilience and associated public and private assistance are effectively communicated to organisations and individuals.

Incorporating disaster risk reduction into sector plans and policies requires a long-term approach and a long-term commitment. The cases in this paper show that effective business recovery largely relies on innovative use of existing services and cross-sectoral collaboration and these are strategies which can be adopted in any country and any sector.

---

<sup>10</sup> See <http://www.resorgs.org.nz>

<sup>11</sup> A multi-sectoral National Platform for disaster risk reduction is a nationally owned and led mechanism facilitating the interaction of key development players around the national disaster risk reduction agenda. The National Platform serves as an advocate for adopting disaster risk reduction measures at all levels.

## References

- Alberta Treasury Board and Finance. (2013). Economic trends. *Economics, Demography and Public Finance, July 2013*.
- Alesch, D. J., Arendt, L. A., & Holly, J. N. (2009). *Managing for long-term community recovery in the aftermath of disaster*. Public Entity Risk Institute.
- APEC. (2013). Building Natural Disaster Response Capacity: Sound Workforce Strategies for Recovery and Reconstruction. Singapore: Human Resources Development Working Group, Asia Pacific Economic Cooperation (APEC).
- APEC TFEP (2008). Dialogue among APEC economies, business community, key International and Regional Partners on Emergency Preparedness, April 2008. Singapore: Asia-Pacific Economic Cooperation (APEC) Task Force for Emergency Preparedness (TFEP).
- Asian Development Bank (ADB). (2008). People's Republic of China: Providing Emergency Response to Sichuan Earthquake *ADB Technical Assistance Consultant's Report*. Beijing: Asian Development Bank.
- BLS (Bureau of Labor Statistics). (2006). The Labour Market Impact of Hurricane Katrina: An Overview. *Monthly Labour Review, 129*(8), 3-10.
- Boen, T. (2008). Reconstruction of houses in Aceh, three years after the December 26, 2004 tsunami. from <http://know.brr.go.id/dc/reports/20080408>
- Brown, C., Seville, E., & Vargo, J. (2013). The role of insurance in organisational recovery following the 2010 and 2011 Canterbury earthquakes. *Resilient Organisations Research Report 2013/04*.
- Brunsdon, D., Crimp, R., Lauder, M., Palmer, R., Scott, I., Brounts, H., & Shephard, B. (2004). *Key considerations for lifeline utility recovery planning*. Paper presented at the New Zealand Recovery Symposium Wellington.
- Cabinet Office. (2011). Disaster Situation, June 24, 2011. <http://www.bousai.go.jp/2011daishinsai/pdf/110624-1kisyu.pdf>.
- Carroll, A. B. (1991). The pyramid of corporate social responsibility: toward the moral management of organizational stakeholders. *Business Horizons, 34*(4), 39-48.
- CCIQ. (2011). Six Months on from Queensland's Natural Disasters: A Report to the Queensland Government *Chamber of Commerce and Industry Queensland's Longitudinal Study examining the Impact of the Natural Disasters on Queensland businesses*. Spring Hill: Chamber of Commerce and Industry Queensland (CCIQ).
- CDC. (2012). Christchurch and Canterbury Quarterly Economic Report May 2012. Christchurch: Canterbury Development Corporation (CDC).
- CERA. (2012). *Christchurch Economic Recovery Plan, presented by S. Wakefield*. Paper presented at the The Logistics of Natural Disaster Recovery 2012 International Conference, 5-7 March 2012, Wellington.
- Chang, Y., Wilkinson, S., Potangaroa, R., & Seville, E. (2011). Chapter 4 Resourcing for post-disaster reconstruction: A longitudinal case study following the earthquake in China. In D. Amaratunga & R. Haigh (Eds.), *Reconstructing for Resilience: Strategies for building sustainable communities after a disaster*. London: Wiley-Blackwell.



- Chang, Y., Wilkinson, S., Seville, E., & Potangaroa, R. (2012). Changes in resource need for post-disaster reconstruction: a longitudinal study in China. *Building Research and Information*, 40(3), 327-336.
- Couto, R. A. (1989). Economics, Experts, and Risk: Lessons from the Catastrophe at Aberfan. *Political Psychology*, 10(2), 309-324.
- CPA Australia. (2009). Disaster Recovery Toolkit for Business. *July 2009*.
- DoL. (2011). A Changing Landscape: The Impact of the Earthquakes on Christchurch Workplaces. In Labour & Immigration Research Centre (Ed.), (Vol. December 2011). Wellington: Department of Labour.
- Earthquake Commission. (2011). Briefing to the Incoming Minister *December 2011*, [www.eqc.govt.nz](http://www.eqc.govt.nz).
- ECLAC (United Nations Economic Commission for Latin America and the Caribbean). (2003). Handbook for the Evaluation of the Socioeconomic and Environmental Impact of Disaster (LC/MEX/G.5). Santiago: ECLAC.
- EERI. (2011). The March 11, 2011, Great East Japan (Tohoku) Earthquake and Tsunami: Societal Dimensions *Learning from Earthquakes*. Earthquake Engineering Research Institute (EERI).
- Experian. (2005). Hurricane Katrina: Impact on outstanding payables to suppliers, white paper. Costa Mesa: Experian.
- FAO (Food and Agriculture Organization of the United Nations). (2005a). Impact of the Tsunami on Fisheries, Aquaculture and Coastal Lives. Rome: Food and Agriculture Organization of the United Nations.
- FAO (Food and Agriculture Organization of the United Nations). (2005b). Tsunami impact on fisheries and aquaculture in Indonesia. Rome: Food and Agriculture Organization of the United Nations.
- Flood Recovery Task Force. (2013). Southern Alberta 2013 Floods: The Provincial Recovery Framework. <http://alberta.ca/albertacode/images/Flood-Recovery-Framework.pdf>. The Government of Alberta.
- Hamel, G., & Välikangas, L. (2003). The Quest for Resilience. *Harvard Business Review*, 81(9), 52-65.
- Hatton, T., Seville, E., & Vargo, J. (2012). Improving the resilience of SMEs: policy and practice in New Zealand, Report prepared for an Asia Pacific Economic Co-operation (APEC) project on improving the resilience of SMEs (Vol. Resilient Organisations Research Report 2012/12). Christchurch.
- Herod, A. (2011). What does the 2011 Japanese tsunami tell us about the nature of the global economy? *Social and Cultural Geography*, 12(8), 829-837.
- Insurance Council of Australia. (2012). Disaster Statistics. <http://www.insurancecouncil.com.au/statistics>.
- International Recovery Platform. (2010). Wenchuan Earthquake 2008: Recovery and Reconstruction in Sichuan Province *Recovery Status Report 04*. Kobe: International Recovery Platform (IRP) Secretariat.

- Japan's Reconstruction Agency. (2012). Current Situation and Measures for Reconstruction on 21 May 2012. [www.reconstruction.go.jp/topics/120521genjototorikumi.pdf](http://www.reconstruction.go.jp/topics/120521genjototorikumi.pdf).
- Jayasuriya, S., & McCawley, P. (2008). *Reconstruction after A Major Disaster: Lessons from The Post-Tsunami Experience in Indonesia, Sri Lanka, and Thailand*. ADBI Working Paper 125. ADB Institute. Tokyo.
- Kachali, H. (2013). *Key Elements of Sectoral Recovery and Resilience after the Canterbury Earthquakes: A System Dynamics Approach*. (Doctor of Philosophy, PhD), University of Canterbury, Christchurch, Canterbury.
- Kachali, H., Stevenson, J. R., Whitman, Z., Seville, E., Vargo, J., & Wilson, T. (2010). Preliminary Results from the Organisational Resilience and Recovery Study, December 2010. Christchurch: Resilient Organisations & University of Canterbury.
- Kaplan, R. S., & Garrick, B. J. (1981). On the quantitative definition of risk. *Risk analysis*, 1(1), 11-27.
- Kim, J., Oh, S. S., & Jung, T. (2010). Funding for disaster recovery: Increased taxes or charitable donations to nonprofits? *International Journal of Public Administration*, 33(3), 151-159.
- Koria, M. (2009). Managing for innovation in large and complex recovery programmes: Tsunami lessons from Sri Lanka. *International Journal of Project Management*, 27(2), 123-130.
- Lam, N., Pace, K., Campanella, R., LeSage, J., & Arenas, H. (2009). Business return in New Orleans: Decision making amid post-Katrina uncertainty. *PLoS ONE*, 4(8), 1-10.
- Lambert, D., & Cooper, M. (2000). Issues in supply chain management. *Industrial marketing management*, 29(1), 65-83.
- Le Masurier, J., & Wilkinson, S. (2006). **Barriers to post disaster reconstruction**: Report on workshop *Resilient Organisations Research Report*. Resilient Organisations.
- Lee, A., Seville, E., & Vargo, J. (2013). Developing a tool to measure and compare organizations' resilience. *Natural Hazards Review (ASCE)*, 14(1), 29-41.
- Liborio, C. S. (2011). Natural disasters: from destruction to recovery *Economic Information Newsletter*. Research Library of the Federal Reserve Bank of St. Louis.
- Lindgreen, A., & Swaen, V. (2010). Corporate social responsibility. *International Journal of Management Reviews*, 12(1), 1-7.
- McManus, S., Seville, E., Vargo, J., & Brunsdon, D. (2008). Facilitated process for improving organizational resilience. *Natural Hazards Review (ASCE)*, 9(1), 81-90.
- McManus, S. T. (2008). *Organisational Resilience in New Zealand*.
- Mileti, D. S. (2005). Disasters by design. *Economics and the wind*, 1.
- Ministry of Finance, GFDRR (Global Facility for Disaster Reduction and Recovery), & World Bank. (2012). Supporting Sustainable Post-Earthquake Recovery in China. Beijing.
- Ministry of Health Labour and Welfare. (2011). 'Japan as One' Work Project. *Press Release on 25 October 2011*.

- Ministry of Social Development. (2011). Christchurch Earthquake Support Package. *available at <http://www.msd.govt.nz/about-msd-and-our-work/newsroom/media-releases/2011/millions-for-christchurch-quake-employment-support.html>*.
- Mount, J., Zinger, J. T., & Forsyth, G. R. (1993). Organizing for development in the small business. *Long range planning*, 26(5), 111-120.
- Nanto, D. K., Cooper, W. H., Donnelly, J. M., & Johnson, R. (2011). Japan's 2011 Earthquake and Tsunami: Economic Effects and Implications for the United States. Washington, D.C.: Congressional Research Service.
- National Australia Bank. (2011). Special Business Survey: Economic Impact of Recent Floods (Vol. 8 February). Melbourne: National Australia Bank.
- Nazara, S., & Resosudarmo, B. P. (2007). Aceh-Nias Reconstruction and Rehabilitation: Progress and Challenges at the End of 2006 *ADB Institute Discussion Paper No.70*. Tokyo: Asian Development Bank Institute.
- NZMEA. (2011). NZMEA Business Survey - March 2011. Wellington: New Zealand Manufacturers and Exporters Association (NEMEA).
- Orchiston, C., Vargo, J., & Seville, E. (2012). Outcomes of the Canterbury earthquake sequence for tourism businesses. *Resilient Organisations Research Report 2012/09, November 2012*.
- Parkatti, M. (2013). Impact of Southern Alberta Flooding on Hours Worked and GDP. *Economic Commentary, Alberta Government*.
- Parker, M., & Steenkamp, D. (2012). The economic impact of the Canterbury earthquakes. *Reserve Bank of New Zealand Bulletin, September 2012, 75(3)*, 13-25.
- Paterson, E., Re, D. D., & Wang, Z. (2008). The 2008 Wenchuan Earthquake: Risk Management Lessons and Implications. *Risk Management Solutions (RMS) Publications*.
- Paton, D. (2007). *Measuring and monitoring resilience in Auckland* (Vol. 2007/18). Wellington: GNS Science.
- Popp, A. (2006). The effects of natural disasters on long run growth. *Major Themes in Economics, 1*, 61-81.
- QRA (Queensland Reconstruction Authority). (2012). Rebuilding a stronger, more resilient Queensland: The capacity to prepare for, withstand, respond to and recover from disasters. Brisbane: Queensland Government.
- Quarantelli, E. L. (1982). What is a disaster? An agent specific or an all disaster spectrum approach to socio-behavioral aspects of earthquakes?
- Reason, J., Hollnagel, E., & Paries, J. (2006). Revisiting the Swiss Cheese Model of Accidents. *Journal of Clinical Engineering, 27*, 110-115.
- Scott, D. (2013). Recover Canterbury's Mission Complete. *Stuff (7 May 2013)*, Retrieved from <http://www.stuff.co.nz/the-press/opinion/8639651/Recover-Canterburys-mission-complete>.
- Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization*: Broadway Business.
- Seville, E. P., Brunsdon, D., Dantas, A., Le Masurier, J., Wilkinson, S., & Vargo, J. J. (2008). Organisational resilience: Researching the reality of New Zealand organisations. *Journal of Business Continuity & Emergency Planning, 2(2)*, 258-266.

- State Planning Group of Post-Wenchuan Earthquake Restoration and Reconstruction. (2008). The State Overall Planning for Post-Wenchuan Earthquake Restoration and Reconstruction. Beijing: National Development and Reform Committee.
- Statistics Canada, & Alberta Enterprise and Advanced Education. (2013). Alberta Economic Results. <http://albertacanada.com/business/overview/economic-results.aspx>.
- Steeman, M. (2011). Horrible year for business in Canterbury. *Stuff* (3 September 2011), Retrieved from <http://www.stuff.co.nz/business/rebuilding-christchurch/5558542/Horrible-year-for-business-in-Canterbury>.
- Steinberg, F. (2007). Housing reconstruction and rehabilitation in Aceh and Nias, Indonesia - Rebuilding lives. *Habitat International*, 31(1), 150-166.
- Stevenson, J. R., Seville, E., & Vargo, J. (2012). The Canterbury earthquakes: Challenges and opportunities for Central Business District Organisations. *Resilient Organisations Report for Asia Pacific Economic Cooperation (APEC)*.
- Tierney, K. J. (2003). Conceptualizing and Measuring Organizational and Community Resilience: Lessons from the Emergency Response Following the September 11, 2001 Attack on the World Trade Center: University of Delaware Disaster Research Center.
- UN/ISDR. (2013). Implementation of the Hyogo Framework for Action: Summary of reports 2007-2013. Geneva: United Nations Office for Disaster Risk Reduction (UNISDR).
- UNISDR. (2005). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters.
- United Nations. (2010). The Chilean earthquake of 27 February 2010: an overview. Santiago, Chile: The Disaster Assessment Unit of Economic Commission for Latin America and the Caribbean (ECLAC), United Nations.
- Venn, D. (2012). Helping Displaced Workers Back Into Jobs After a Natural Disaster: Recent Experiences in OECD Countries. *OECD Social, Employment and Migration Working Papers, No. 142*, OECD Publishing.
- Waugh Jr., W. L. (2009). Katrina and the governors. *Public Organization Review*, 9(4), 343-351.
- Whitman, Z. (2013). Rural organisational impacts and resilience to natural hazards. *University of Canterbury*.
- Whitman, Z., Seville, E., Wilson, T., & Vargo, J. (2012). The Canterbury Earthquakes: The Impact on Farming Organisations. *Resilient Organisations Report for Asia Pacific Economic Cooperation (APEC)*.
- Whitman, Z. R., Kachali, H., Roger, D., Vargo, J., & Seville, E. (2013). Short-Form version of the Benchmark Resilience Tool (BRT-53). *Measuring Business Excellence*, 17(3), 3-14.
- Wildavsky, A. B. (1988). *Searching for safety*: Transaction publishers.
- Wood, A. (2011). Christchurch earthquake: 195 redundant at Canterbury Spinners. *The Press*.
- World Bank. (2005). Indonesia: Preliminary Damage and Loss Assessment: The December 26, 2004 Natural Disaster. Jakarta: The World Bank.
- World Bank, & Queensland Reconstruction Authority. (2011). Queensland Recovery and Reconstruction in the Aftermath of the 2010/2011 Flood Events and Cyclone Yasi.

Yuasa, S. (2011). Japan exports sag in April after tsunami *Atlanta Journal-Constitution*, 25 May.

Zhang, Y., Lindell, M. K., & Prater, C. S. (2009). Vulnerability of community businesses to environmental disasters. *Disasters*, 33(1), 38-57.