

# Transport Resilience and Earthquakes – Learning Lessons from Christchurch

Dr Glen Koorey

Principal, ViaStrada Ltd, Christchurch

## Abstract

***How do people respond to dramatic changes in transport patterns? What can other communities learn from the transport effects of the Christchurch earthquakes?***

*Typically, transport patterns in a city only change gradually over time, as land use and population patterns evolve and new transport facilities are developed or modified. That altered dramatically in Christchurch following the 2010 and 2011 earthquakes. In a very short time, the city experienced rapid transformations in the shape of both the transport network and the surrounding land uses.*

*While that created significant problems for the provision of adequate transport options, it also allowed the opportunity to radically rethink the nature of how we get around the city in the future. This paper summarises some of the key post-quake transport changes in Christchurch and identifies a number of valuable lessons for other areas faced with similar disasters.*

## **Key-words:**

Transport, earthquakes, life-lines, resilience, rebuild, road networks

## Introduction

Transport is not an end in itself; it exists to allow people to access various activities and services. Hence, transport involves a complicated relationship between the various land uses present (residential, employment, recreation, education, commercial) and the different transport networks and services provided (roads, paths, bus services, railways, and more).

These interact to form the 'flow pattern' that we experience; for example, which are the heavy transport routes, how many people use the bus, what times of the day and week are busiest and so on. Typically, these patterns in a city only change gradually over time, as land uses and population patterns change and new transport facilities are developed or changed.

All that changed dramatically in Christchurch following the 2010 and 2011 earthquakes. In a very short time, the city experienced rapid changes in the shape of both the transport network and the surrounding land uses. While that created significant problems for the provision of adequate transport options, it has also allowed the opportunity to radically rethink the nature of how we get around the city in the future. This paper summarises some of the key post-quake transport changes in Christchurch and identifies a number of valuable lessons for other areas faced with similar disasters.

## Immediate post-quake effects

The September 2010 earthquake had the distinct immediate 'advantage' that most people were still at home when it occurred in the early morning. This limited the amount of traffic that was on the streets at the time. By contrast, the February 2011 quake and many of the other significant aftershocks occurred during the daytime when many people were at work, school or activities like shopping. As a result, there was significant traffic congestion immediately following these quakes, as people were typically evacuated from major buildings and sent home (a similar problem was seen in Wellington following the 2013 Seddon earthquake). Damage to parts

of the road network and traffic signals also contributed to the ensuing gridlock in many parts of the city.

Interestingly, a very resilient travel choice in those immediate post-quake times was cycling. People who were cycling home were generally able to ride past queued traffic and also to get around many obstacles on the street that were too big to allow motor vehicles through. The importance of a travel mode like the bicycle in times of emergency should not be underestimated; indeed, in Portland, Oregon, they hold annual 'disaster relief trials' using a variety of cargo-carrying cycles to navigate an obstacle course and to 'deliver' emergency supplies (Maus 2015).

The major quakes in Christchurch resulted in many instances of flooding due to ground liquefaction and burst pipes. Many roads were very uneven due to ground movements, and in some cases damaged by major slips, cracks or sinkholes (see Figure 1). Many services in the ground (e.g. manholes and sumps) also rose relative to the road surface, creating additional solid obstacles to negotiate. Similarly, bridges often ended up at a different level to the adjacent roads, making it difficult or impossible to use them, and most bridges and tunnels also had to be closed following each major shake while being checked for structural damage.

Good transport connections are important for maintaining normal freight supplies; following a disaster like this they also become a lifeline for other essential needs. For example, much of Christchurch was without clean drinking water following the major quakes. Therefore, plans were organised to bring in supplies from out of town by rail and then distribute it via local community tankers.

Fuel supplies into Christchurch were generally well managed following the major earthquakes, with normal port deliveries able to be carried out. Despite this, rumours abounded about potential fuel shortages, resulting in long queues at service stations while everyone filled up their tanks 'just in case'.

### **Lessons Learned:**

- The road network may be significantly affected by the utilities infrastructure that is *under* it when an earthquake strikes. For example, changes in density between “soft” underlying ground and adjacent “hard” structures (bridges, sumps, etc) can produce a network that is very uneven and hard to navigate by motor vehicle.
- Panic buying of supplies like petrol or food and water is not unusual following a disaster situation (or ahead of it, if people are forewarned), and needs to be managed with good public communication and inventory supply.

### **Land use changes**

Many people’s homes were seriously damaged, thus requiring them to find new accommodation. Typically, these new abodes were in outer suburbs that had suffered less damage, including parts of the adjacent Waimakariri and Selwyn Districts. Quite quickly, new subdivisions have also sprung up on the periphery of the city to cater for the demand. The net effect has been to increase the average travel distances for people to get to work, school and other common destinations.

With many business premises out of action following the quakes, employers were also forced to improvise. Relocated workplaces (whether temporary or permanent) sprung up rapidly, typically outside of the Central Business District (CBD) that had been hit the hardest (and it was cordoned off for as much as two years). As a result, employees had to learn new travel patterns to their new workplaces.

Alternatively, some businesses shifted to more staff working at home; for example, Telecom call centre staff were given the necessary systems to do their work from home (Steeman 2011). The University of Canterbury made greater use of its online learning system when staff and students were restricted from being on campus. It may be that some of the resulting trip reductions

become permanent as these ‘tele-commuting’ techniques gain wider acceptance.

Schools also had to change their habits. A number of schools temporarily shared sites to assist those schools with serious damage (Ham *et al* 2012). School timetables were adjusted to fit two compressed teaching blocks into each day, with one school using the site in the morning and one in the afternoon. To minimise the potential traffic impacts, the ‘visitor’ school pupils were transported to their host site every day via a fleet of buses.

These land use changes led to some significant changes to transport patterns. The shift in trip origins and destinations saw some dramatic swings in traffic flows, with eastern parts of the city and the CBD typically seeing less traffic and western parts of the city and the outskirts seeing greater flows (Figure 2). In many cases, the busier roads were not well equipped to handle the ‘overnight’ increases in traffic. Travellers’ previously developed habits were disrupted by having to journey to and from new places. If they previously took a bus, this option may have been less obvious or available now (especially with so many bus routes historically travelling to the now-empty CBD). If they biked, a suitably safe route on their new trip may also not have been evident. The longer average journeys also meant that those used to walking and cycling often made a switch to driving.

Another interesting phenomenon with the ongoing aftershocks was many people’s desire to keep their cars close by, in case they had to get to family following another major shake. This undoubtedly had an impact on travel by other modes, especially buses. Ironically, the reasoning was probably somewhat misplaced, given that many cars were trapped in carpark buildings following the major quakes and the ensuing congestion heading home invariably made it quicker to get around the city by biking or even walking.

### **Lessons Learned:**

- Changes to where people work and live in the short term following a disaster may dramatically affect the use of established travel patterns by walking, biking or public

transport. Transport organisations may have to work swiftly to enable alternate routes using means other than driving.

- Many innovative and workable solutions can be found following a disaster to accommodate damage to accommodation, workplaces, schools, etc. It is important however to consider the transport implications of such changes, especially when they involve longer travel distances than before and potential reductions in use of sustainable transport modes.

### **Short-term transport treatments**

While bus services were suspended immediately following the major earthquakes, limited services typically resumed within days, although some routes were redirected to avoid road closures. The previous CBD Bus Exchange was severely damaged, and two temporary interchanges were set up on the outskirts of the CBD, each servicing half the city with a free link bus connecting them. A trip across the city on the same bus might now take three buses; not surprisingly this sub-optimal system resulted in approximately 50% of previous patronage levels. The situation was finally resolved in October 2011 when an interim “Central Station” in the CBD was able to take on the role of the previous Exchange until more permanent facilities were constructed later.

Another series of controversial short-term operational changes in April 2011 were the removal of some parking lanes and cycle lanes near congested intersections to enable additional traffic lanes to be extended. These were pushed through very quickly under emergency powers but drew widespread criticism from cycling circles. Ostensibly these moves were to ‘reduce congestion’; yet making it harder to ride safely on Christchurch’s streets obviously discouraged this travel choice. It is notable that no ‘emergency powers’ were used to remove parking and implement any bus or cycle lanes that may have improved alternative transport options.

### **Lessons Learned:**

- Major disasters allow the opportunity to introduce emergency measures without the usual consultative process. However, consideration should be given as to whether this opportunity is better used for road traffic improvements or other travel mode improvements.

### **Opportunities for change**

With the immediate transport issues resolved, thoughts turned to how to reconfigure the transport system while rebuilding the city. The Christchurch City Council’s ‘Share an Idea’ campaign (comprising a public expo, printed/online consultation material, media articles, online discussion forums, and various seminars) elicited considerable public feedback on this topic. Some of the most common transport suggestions included:

- shifting to a more ‘people-friendly’ central city, with a much better environment for walking;
- reviving Christchurch’s historic high use of cycling, by providing suitable protected cycleways;
- developing a rail-based public transport system, using both the existing main trunk lines and new light rail routes;
- abolishing the CBD’s one-way streets, which were cited as a blight on urban streetscapes; and
- removing requirements for CBD developments to have a minimum number of car parks, allowing developers to determine their own needs and to encourage more use of other transport modes.

It is notable that, just prior to the earthquakes, the Council had commissioned prominent international urban space experts Gehl Architects to investigate options for revitalising the central city. Gehl’s recommendations included virtually all of the above ideas, yet the Council’s response to it at the time was decidedly muted (CCC 2010). Only the circuit-breaker of the devastating

earthquakes allowed the Council to reconsider some of the 'radical' ideas suggested by Gehl.

CERA (the Canterbury Earthquake Recovery Authority) took the Council's resulting Draft Central City Plan, submitted to central government in December 2011, and then announced the development of its own Christchurch Central Recovery Plan (CCRP) loosely based on these concepts. While the CCRP was developed in a whirlwind 100-day period and released in July 2012, the transport component was held back to allow detailed modelling of options to be undertaken. It wasn't until November 2012 that the draft transport chapter of the CCRP, "An Accessible City", was released for consultation. After submissions closed in February 2013, CERA's final transport plan was released in October 2013 (CCDU 2013), with notably little change from the original draft and nearly two years after the Council had submitted its own transport plan.

The initial Council plan had quite a strong push for rail-based public transport, including the development of new light rail routes (Figure 3). The first proposed route, from town to Canterbury University via Riccarton (and ultimately to the airport) was costed at around \$400 million. Further connections out to other suburbs would ultimately take the price tag to \$1.5 billion. However, by the time CERA's plan emerged, the word 'rail' wasn't even mentioned, with enhanced bus corridors being the public transport method of choice. Meanwhile, although the one-way streets received a lot of condemnation, CERA's plan will convert only one of the existing four pairs back to two-way. However, the 'look and feel' of these routes will be considerably changed, and efforts will be made to encourage cross-city traffic onto the wider 'four avenues' that ring the CBD.

"An Accessible City" also proposes a more people-friendly CBD 'core' where active travel modes (especially walking) will receive priority and safety. This core will include various traffic-free areas as well as a comprehensive 30 km/h zone for much of the central city (introduced in March 2016). Cycling will also receive a boost via a combination of separated cycleways and

various quiet streets and 'greenway' connections throughout the CBD.

In parallel with CERA developing their plan, the Council had continued to work on developing its "Christchurch Transport Strategic Plan" (CCC 2012), a 30-year blueprint for the whole city, which had been well in development prior to the quakes. This contains a similar shift in focus towards more sustainable transport options, while recognising the then-Government's desire to roll out 'Roads of National Significance' (RoNS) motorways around the city's periphery. Unlike CERA's plan, the Transport Strategic Plan still mentions the potential for rail-based public transport, but typically couches it as a sufficiently future possibility.

"An Accessible City" also recognised that the rebuilt city would have to better accommodate those people for whom accessibility is an issue, such as wheelchair users and vision-impaired pedestrians. In the immediate aftermath of the quakes, many of the temporary walking routes around the city were virtually impassable by people with such impediments, with a lack of recognisable cues, kerb ramps and the like. Over time this improved during the rebuild, with some contractors arranging for 'walkability audits' of their work sites. The finished city should better incorporate such accessibility features to truly provide for all users.

Cycling came in for increased attention, and Council's Transport Strategic Plan aimed to develop a series of high quality 'major cycleway' routes connected by other local cycleways to form a comprehensive citywide network. Initially it looked like this would be a slow-burning development across the ensuing decades. However, in July 2013, the Council allocated \$69 million over five years for a programme of thirteen major cycleway routes across the city (although that cost was subsequently revised upwards). This was informed by the development that year of the *Christchurch Cycle Design Guidelines* (CCC 2013), which painted a vision of how many of the new routes would incorporate features commonplace in more cycle-friendly parts of the world but quite new to New Zealand. Four of these cycleways have now been completed (see Figure 4), with others under

construction, and already city cycling numbers have increased by 15-20% within the past year.

The notion of a new people-friendly city was celebrated in September 2013 by means of a 'ciclovia' or 'Open Streets Festival' (Koorey 2013). In a first for a New Zealand city, the streets throughout the central city were closed off to motor traffic for a day allowing people on foot or bike free rein of the central city.

It wasn't just public organisations that saw the opportunities for new transport networks in the rebuild. Two particular grassroots community organisations arose that resonated strongly with the general public and ultimately the politicians. The Christchurch Coastal Pathway group proposed a new walking and cycling route along the foreshore from Ferrymead out to Sumner (about 8 km) for both transport and recreation; by 2013 the Council had committed to \$9 million of its expected \$19 million price-tag, and it is now 70% complete. Meanwhile, the Avon-Otakaro Network proposed new pathways along the largely red-zoned Avon River from the CBD out to New Brighton; a petition to Parliament in 2012 gathered more than 18,000 signatures. Currently pathway options for this corridor are being finalised.

### ***Lessons Learned:***

- The "blank canvas" afforded in many cases following the quakes allowed the city to plan for a future transport network that was radically quite different in direction to previous plans; for example, more immediate implementation of sustainable transport initiatives.
- It is not necessary to have a disaster before a district asks its residents what kind of community they would like. The Christchurch "Share an Idea" provides a template that could be used at any time to gauge the true aspirations of the public.

### **Managing the transport rebuild**

Notwithstanding the dramatic changes prescribed for much of the city's transport

network, a more immediate issue was the need to repair a large proportion of the city's roading stock and underlying pipe infrastructure. Virtually all of the streets on the eastern side would require reconstruction and many on the western side too.

Traditional client-contractor arrangements were seen as too cumbersome for the sheer scale of works required. Therefore, a radical new arrangement was needed to efficiently implement the \$2.5 billion of basic 'horizontal infrastructure' works. A new alliance of three clients (CCC, CERA and NZTA, the NZ Transport Agency) and five contractors came together to form SCIRT – the Stronger Christchurch Infrastructure Rebuild Team. Staff from these organisations and some engineering consultancies were seconded to SCIRT to help plan and design the rebuild works and progressively roll them out across the city over about six years.

SCIRT is a highly efficient arrangement for the reconstruction of 'like for like' facilities, with the costs being covered by insurance. A similar structure, the North Canterbury Transport Infrastructure Recovery alliance (NCTIR), is being used for the rebuild of the Kaikoura coast corridor following the 2016 quakes. However, the sheer pace of work undertaken meant that opportunities were often missed to reconfigure a street for modern-day design philosophies (e.g. speed management of local streets) or to add extra value at the same time (e.g. new cycleways). Only as the city's other strategic plans were finalised was there the chance to consider how to take advantage of the ongoing rebuild programme to build back better at the same time.

The increasingly busy traffic patterns around the city also resulted in better coordination between the Council (responsible for local roads), Environment Canterbury (responsible for bus services), and NZTA (responsible for state highways). A 'Christchurch Transport Operations Centre' was set up to oversee the combined road networks (for example, developing real-time travel time information), and a new website 'Transport for Christchurch' promoted the many different transport options available to people and described current road-works closures.

## Lessons Learned:

- An integrated client-consultant-contractor operation like SCIRT provides a very useful model for efficient rebuild of essential infrastructure following a major disaster. However, care needs to be taken that the process does not simply lead to 'like for like' replacement of transport assets without the opportunity to improve them at the same time.
- The greater coordination necessary between transport agencies immediately following a disaster may in turn lead to better coordination across other transport management issues; however, it is probably better if the process is the other way around.

## Conclusion

The Canterbury earthquakes identified a number of valuable lessons for other areas faced with similar disasters. These may be lessons for use in advance of such an event (i.e. preventative measures), as well as lessons on what to do in the immediate aftermath, and in the longer term.

The transitional nature of many parts of the transport network (and adjacent land uses) post-disaster allows an element of 'experimentation' to be undertaken that politically may be difficult to achieve otherwise. While certainly not a desirable way to reach this state, it does provide a rare opportunity to reinvent the transport mix in the city for ultimately a better outcome.

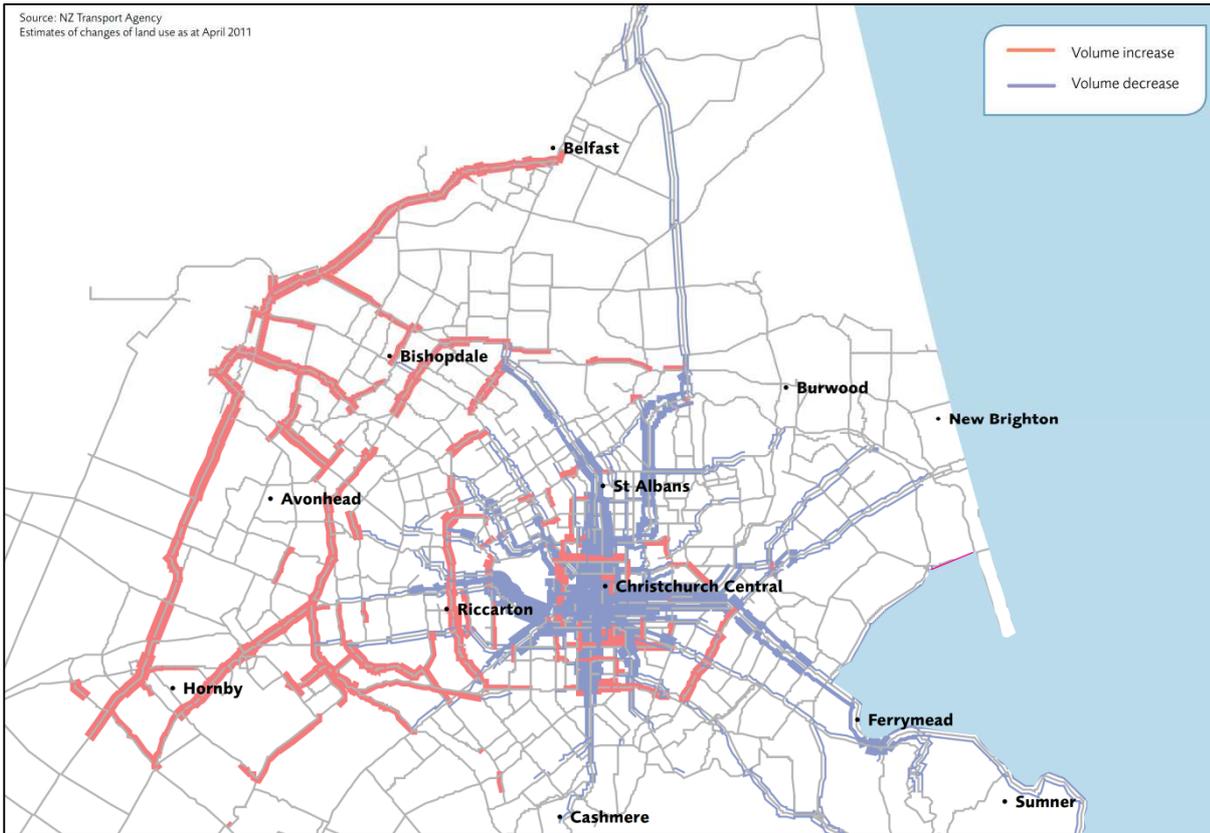
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***Figure 1: Example of road damage following 2010-11 Canterbury quakes***



**Figure 2: Map of changes to traffic flows around Christchurch, April 2011**



(Source: NZ Government 2011)

**Figure 3: Proposed Christchurch Passenger Rail Network**



(Source: CCC 2011)

**Figure 4: New separated cycleway in Christchurch**



### **About the author**

Glen Koorey joined ViaStrada as a senior traffic engineer in April 2016, after 12 years as a senior lecturer in transportation engineering at the University of Canterbury. Prior to that he was a consultant researcher with Opus International Consultants.

He specialises in road safety and sustainable transport, but has also undertaken research and consulting work across numerous areas, including rural highway operations, road network reliability, and future transport technologies.

Dr Koorey experienced the Christchurch earthquakes first-hand and was involved in numerous rebuild-related activities including student master-planning projects and the Major Cycleway network. He contributed a chapter on post-quake transport in the 2014 book *“Once in a Lifetime: City-building after Disaster in Christchurch”* (Freerange Press).

Email: [glen@viastrada.nz](mailto:glen@viastrada.nz) Post: c/ ViaStrada Ltd, PO Box 22-458, Christchurch