



Kaikoura Earthquake – One Year On

Introduction

The fact file below (Figure 1) summarises the main features of the earthquake.

Figure 1 Fact file

- Occurrence at 12.02am local time on November 14th 2016 (November 13th at 11.02am VCT)
- Moment Magnitude (MM) 7.8
- Epicentre in the Waiiau Plains of North Canterbury 15km north east of Culverden, 60km south west of the tourist town of Kaikoura.
- Depth 15km, i.e. very shallow hypocentre (focus)
- Complex sequence of ruptures along multiple fault segments leading to maximum ground shaking and thrusts over a wide area
- Duration for about two minutes. Waves propagated north over 150km to Cape Campbell and Wellington on North Island
- Ground motions with accelerations exceeding 1.0g
- Second largest earthquake ever in New Zealand. Largest energy release at Seddon. Vertical fault thrusts of over 2m (at Kaikoura) as a result of the Slapdown effect
- Two people died, fifty-seven were injured
- Very widespread damage, often as a result of secondary impacts such as tsunami and landslides.

Commentary

1) Fault Ruptures

Figure 3 Fault ruptures

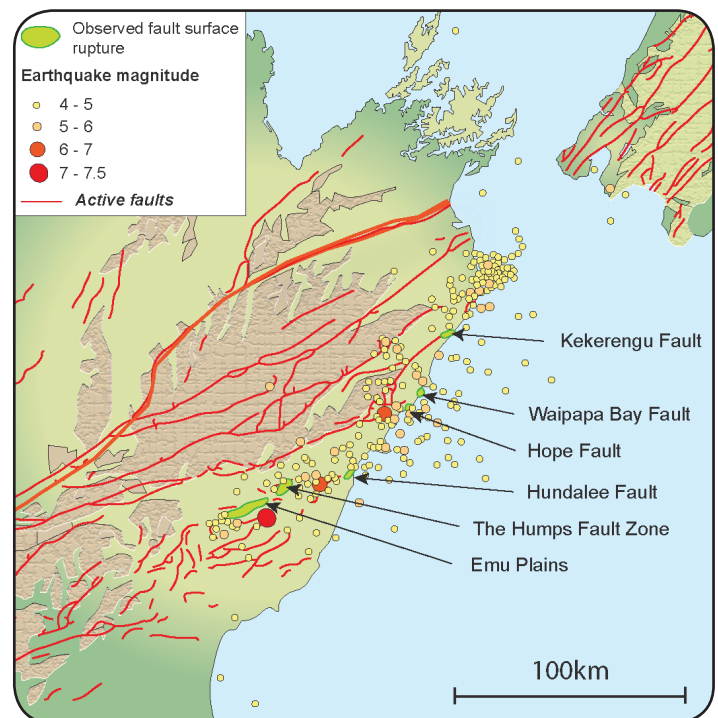


Figure 2 The spatial impact of the Kaikoura earthquake

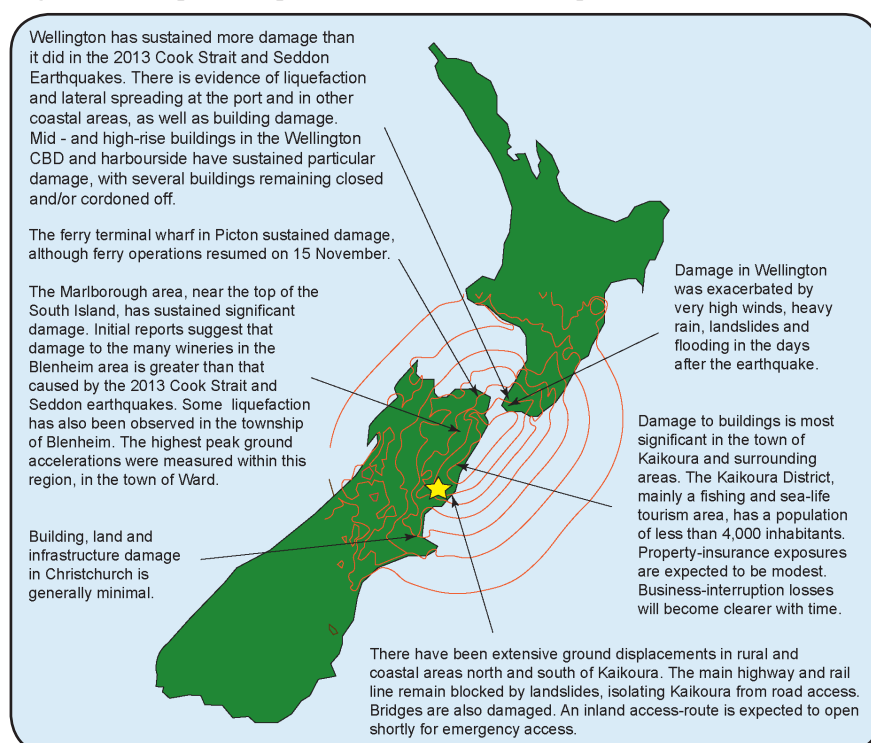


Figure 3 shows the mapped fault ruptures which occurred co-seismically along up to 10 major faults. This very complex fault pattern of these interlinked faults is one reason for the very widespread damage, and it has also provided amazing opportunities for geological analysis.

<https://www.nzgeo.com/stories/in-the-wake-of-the-quake/>

2) Tsunami

Table 1 shows the results of a small to moderate sized local tsunami which was generated by vertical displacements along off-shore faults such as the Needles Fault. The peak recorded tsunami was at North Wharf, Kaikoura (2.31m). The impact was compounded by the 1m of uplift experienced as a result of thrusting which offset the potential for widespread flooding. The maximum run up elevations were experienced at Little Pigeon Bay (4-5m) and Goose Bay (nearly 7m) where local conditions amplified the impact resulting in sea wall damage.

Table 1 Data from New Zealand tide gauges

The gauge measure	Time of observed arrival of tsunami (VTC)	Peak amplitude (above sea level in metres)	Time of peak amplitude
Castlepoint	12.00	0.25	13.12
Kaikoura North Wharf	11.13	2.31	11.44
Chatham Islands	14.25	0.16	17.29
Queens Wharf	11.13	0.46	13.00

3) Landslides

Figure 4 Landslides showing damage to the infrastructure – both road and railway



Landslides affected a total area of 10,000 square km with the majority concentrated in a smaller area of about 3,500 km². Some 80,000-100,000 were mapped. Local geology, relief and the degree of ground shaking were the key causal factors affecting distribution with sedimentary sandstones, limestones and clays being the main rock types affected. A wide variety of landslide types occurred ranging from rotational rockslides to rock and debris avalanches. Many of the landslides (190) were very large and actually blocked river valleys, e.g. Hapuku. They represent, until managed, a potential risk to agriculture, aquaculture and infrastructure as they can be reactivated by heavy rain or ground shaking from aftershocks forming temporary dams. The landslides were also concentrated along the steep coastal cliffs which had major implications for the communications networks – perhaps the **key impact** of the earthquake.

4) Aftershocks

Aftershocks, often up to 20 a day, were concentrated in a broad region from North Canterbury across Cook Straits to an area north of Wellington. They have included several major earthquakes over MM6. They have led to a major rethink on retrofitting buildings to

make them aseismic in Wellington and have also led to the removal of some capital city functions and businesses to Auckland (north of North Island) which is considered relatively seismic risk free.

5) Liquefaction

Liquefaction and its associated impacts on buildings was relatively insignificant compared to the landslide hazards in stark contrast to the widespread liquefaction caused by the 2010-11 Christchurch area earthquake, which were of much smaller magnitude (MM5-6). This is the result of different ground conditions which were prevalent in the Christchurch area but not in the Kaikoura area. The most severe liquefaction was found north and east of Blenheim in the Wairau river flood plain in the abandoned meander channels and also in the reclaimed land area along Wellington waterfront (impact on CentrePoint).

6) Damage

In terms of **social impacts**, only two people were killed and only fifty-seven injured, largely from flying debris of collapsed buildings. These low totals were not only the result of effective rescue systems,

but also due to the fact that the area of most severe, direct impact occurred in very sparsely populated areas. So, whilst a high percentage of houses were affected, dwellings were far less numerous except in Kaikoura, a town of nearly 3,000 permanent population. Nevertheless, as the earthquake was of such high magnitude with maximum ground shaking and thrusting, the **economic impacts** have proved major at a regional scale within North Canterbury. A number of websites, such as <http://www.stuff.co.nz/> or <http://www.treasury.govt.nz/>, show calculations for the damage caused by Kaikoura earthquake. This is currently estimated at \$3.5 billion (US\$) of which \$2 billion were for negative externalities from transport and infrastructure damage which impacted upon business operability and tourism. This compares to Christchurch 2010/11 which was estimated at \$9 billion

but was subsequently raised to \$18.5 billion.

Currently, unlike Christchurch, it is thought improbable that Kaikoura earthquake will have an impact on the national economy as the region only contributes 0.4% to it. However, although New Zealand is a developed country, it only has the 53rd largest GDP of all the countries of the world and a population of just 4.7 million; any major hazard events do have an impact. Following in the wake of Christchurch 2010/11, the impact is likely to be more significant. Christchurch area contributed over 10% to the national economy and so here the national impact of damage losses and recovery costs have been severe.

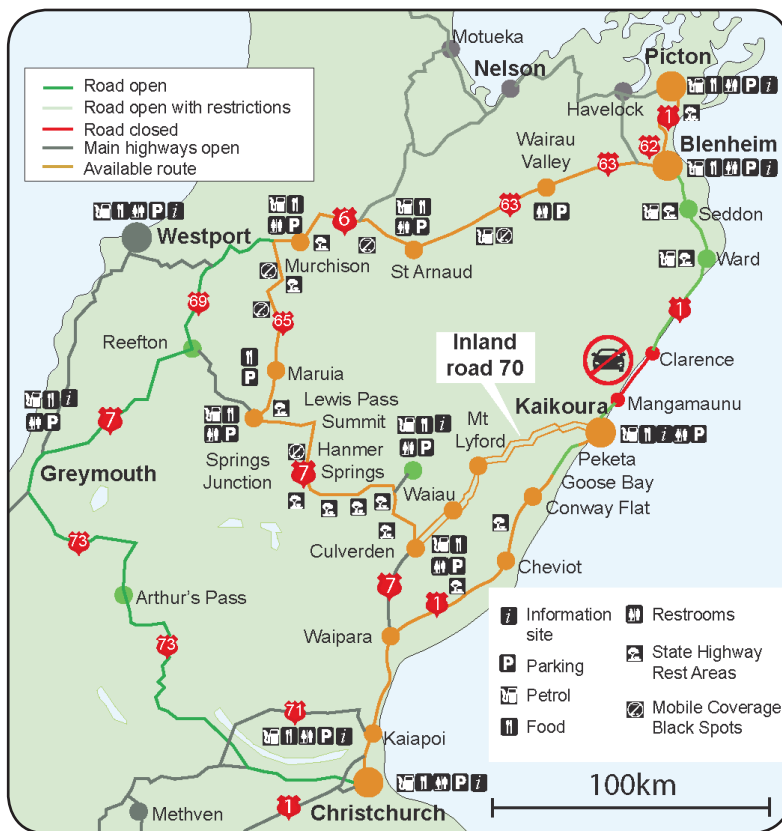
The impacts of Kaikoura earthquake one year on

Whilst the earthquake resulted in short term loss of power, water supplies and fibre optic cables (broad band), the real problem was **transportation** infrastructure damage along the east coast of the South Island. Landsliding, fault ruptures and bridge damage closed a large section of state Highways, both north and south out of Kaikoura and the main Kiwi rail line from Ward South to Cheviot.

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Thus, it can be seen when looking at a number of economic impacts it is the long-term destruction of the transport infrastructure which has had the greatest impact, especially for Kaikoura township.

Figure 5 The situation a year after the earthquake



Route map of road damage

- SH1 was opened from Kaikoura to Christchurch but only during day light hours and even then, there are closures for major works from around March 2017.
- SH1 north from Kaikoura through to Blenheim remains closed with major problems from Mangamaunu to Clarence. It was due to be reopened for Christmas 2017 on a temporary basis. Currently all traffic has to go around via the inland route, adding around seven to eight hours to a journey from Blenheim to Kaikoura. The rather narrow/winding inland route has to be used as a supply line for bridge girders, etc. (see Figure 6).
- The East coast railway route is currently closed and is expected to reopen in 2018. At present, freight has to be shipped via a new coastal shipping service.

Figure 7 shows the complex nature of the repairs and the massive scale of the engineering works.

www.nzta.govt.nz/kaikoura-earthquake-response: this provides details for a series of bulletins so you can view progress each week.

Figure 6 New bridge girder on the move



Figure 7 Engineering works



A. Kaikoura Township impacts

Within Kaikoura there were 36 red tagged buildings (34 residential and 2 commercial) which had to be demolished, as well as 270 yellow tagged structures which needed a huge amount of rebuilding to be safe. Additionally, there were 1900 white tagged liveable in but slightly damaged structurally, i.e. most of the town! Whilst there were short term problems with water systems, the real issue was that Kaikoura as a tourist town had no access in the peak summer season – even the Christchurch route was not open for over a month. Initially tourist numbers were in freefall, with minimal occupancy of backpacker lodges and hotels with only 50% of tourist numbers by the end of 2017. Kaikoura was also renowned for its marine life

– whales, dolphins and albatrosses - and as the seabed was lifted by 2 metres, there was no way of launching boats except winched from vehicles.

By November 2017, the revamped harbour was nearly complete, having been dredged out, and companies, such as *Encounter Kaikoura – Dolphins and Whales*, were operating at nearly 70% capacity. It is hoped that 2018 will lead to a full recovery of both New Zealand and International tourism, but it is often difficult to overcome the psychology of tourists who thought Kaikoura was not ‘open for business’.

Somehow Kaikoura survived without tourists and is on the cusp of a return to normal.

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B. Recovery in Waiau – the village closest to the epicentre

Waiau is the centre of a thinly populated rural community. It is a sub-town of under 300 people. It lost its pubs, historic cob stone cottages, bowling green, church, swimming pool and initially nearly half the school roll because of temporary outmigration from damaged housing.

Throughout the district 74 properties were red-stickered as far too dangerous to inhabit, whilst 262 have a yellow sticker denoting some damage. These damaged buildings are spread across the large area of Hurunui. Whilst the numbers might seem low, the effect on the community is massive. There are major problems in both rehoming people (there is little spare housing stock) and in repairing their houses, with limited access to building professionals, most of whom have been snapped up by the huge infrastructure rebuilding programme for roads and railways. A recent progress report suggested that the insurance claims process is generally well advanced, with 65% of claims for buildings settled, as are 90% of the claims for house contents. However, confusion remains between the various agencies and what to do about the 15% of people who were under insured. The lack of resolution has clearly added to the psychological stress of living in often poor quality, temporary accommodation for over 9 months.

C. Clarence, Seddon and Ward – north of Kaikoura

The closure of SH1 North has affected everyone – the area has been described as the World’s biggest cul-de-sac. Business operability has been affected, often in a negative way, including Clarence River Harvest – a beekeeping and honey production business – which has experienced additional transport bills of \$50,000NZ to get to the hives via an eleven-hour drive, or Burkhart Fisheries, where road closure and sea bed uplift have had a devastating impact as they have been unable to launch the boats to catch the crayfish and get them to the processing plant.

Yet other businesses such as Seddon Cosy Corner Café and Flaxbourne Services, a roadside café and general store, have actually increased their business because of all the workers (up to 2000) repairing the road, so it is not all bad.

D. Performance in the Marlborough Wine Industry

The Marlborough region produces 66% of all New Zealand wines. However, whilst 20% of the wine storage tanks suffered some damage it is suggested that loss of wine production amounted to just 2% largely because the earthquake occurred in November (Spring) and there was a chance to rebuild by the harvest.

E. Ecological damage

The Ohau Point fur seals have lost their idyllic waterfall and pool as a result of landslipping caused by the earthquake as tonnes of rock came crashing down. The earthquake struck in the breeding season (some 2000 fur seal pups in a normal year) but numbers of deaths are hard to record/measure. 274 dead seals have been recorded although some have died (41) as a result of road building accidents. A huge effort has been made to minimise the impacts of the road rebuild and seal handlers have removed up to 10,000 seals to safety from the works (often the same individuals!). It would seem the seals are remarkably resilient – although this year’s breeding season is still being monitored.

Colonies of Pauia have suffered more as a result of the uplift of the sea bed by thrust faulting. Emergency closure of fisheries allowed stocks

to recover but thus had a negative economic impact. The already endangered Hutton’s Shearwater lost 15% of its nesting burrows as a result of earthquake damage to the Kaikoura range. However, this year, the birds have returned. Destruction occurred on some unique plants such as the Ohau rock daisy – a survey suggested that earthquake and landslide damage have reduced this unique species to around 100 plants, so 200 plants have been raised at Tolobi nursery at Brightwater near Nelson for replanting at Ohau Point.

Surveys of whale and dolphin populations have shown no decrease, a real bonus for the tourism industry.

Conclusion

It is possible that one year on it is too soon to assess the degree of impact and ongoing surveys are continuing.

There is no doubt that the New Zealand government has learned much from Christchurch 2010/11, and also Seddon 2013, as how to manage the recovery phase, in particular by developing coordinated emergency response management systems with seamless transfer, from an emergency stage management structure to a recovery management structure. A major problem at Christchurch was the lengthy delay in settling insurance claims and for the Kaikoura earthquake the Earthquake Commission has been formed to coordinate claims to process all land damage claims.

A visit to the area one year later confirmed that a spurt of optimism prevailed and that, once the transportation infrastructure was reopened, 2018 should see an almost total recovery especially for businesses and tourism.

This is remarkable considering the magnitude of the earthquake and the extent of severe damage.

Question: Analyse the importance of ‘geography’ (physical and human) in influencing the impact of, and recovery from, the Kaikoura earthquake.

Further Research

Aftermath – Dan Kerins – photographs of earthquake damage obtainable from Kaikoura Museum

7.8 Life after the Kaikoura earthquake by Phil Pennington. NZ Herald

Weekly earthquake recovery bulletins can be obtained from info@nctir.com and www.nzta.govt.nz/kaikoura-earthquake-response

A full report on earthquake impact is available in pdf format: <http://www.eeri.org/>

‘In the wake of the quake’: <https://www.nzgeo.com/stories/in-the-wake-of-the-quake/>

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