The 09/03/2010 Darfield Earthquake and its Aftershocks, Including the 02/21/2011 Christchurch Event

Educational Slides
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Darfield Earthquake, 09/03/2010, Mw 7.0

Estimated Fatalities

- Red level: high economic losses. Extensive damage is probable and the damage is clearly widespread. Major economic losses are 0.5% GDP of New Zealand. Potentially heavy losses will require a national or international level response.

- Yellow level: high economic losses. There is a local level of casualties.

Estimated Economic Losses

- Red level: high economic losses. Extensive damage is probable and the damage is clearly widespread. Major economic losses are 0.5% GDP of New Zealand. Potentially heavy losses will require a national or international level response.

Estimated Population Exposed to Earthquake Shaking

- Red level: high economic losses. Extensive damage is probable and the damage is clearly widespread. Major economic losses are 0.5% GDP of New Zealand. Potentially heavy losses will require a national or international level response.

Population Exposure

- Red level: high economic losses. Extensive damage is probable and the damage is clearly widespread. Major economic losses are 0.5% GDP of New Zealand. Potentially heavy losses will require a national or international level response.

Structures:

Overall, the population in this region resides in structures that are highly resistant to earthquakes, although some vulnerable structures exist.

Historical Earthquakes (with MMI levels):

- 1931-05-13, 2.0
- 1946-02-15, 1.0
- 1946-08-24, 1.0
- 1963-05-18, 1.0

Selected City Exposure

- Christchurch: 26
- Timaru: 25
- Cambridge: 8
- Gore: 7
- Dunedin: 7
- Invercargill: 7

Event ID: us2010cuj
Comparing Population Exposure

Much greater exposures at high intensities for the Christchurch earthquake.
This Google Earth snap-shot shows the extent of earthquake ground shaking (from USGS ShakeMap; represented in color) overlain on population density (from LandScan 2008, Oakridge National Labs; represented as height of vertical bars) at a grid size of 1 km$^2$. 
In Christchurch, accelerations were much higher during the 02/21 event - up to x6 the accelerations of the Darfield earthquake.
The concentration of higher accelerations coincided with the regions of highest population density. Population data from LandScan 2008, Oakridge National Labs.
### Comparing Shaking Distributions

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Table comparing peak ground accelerations (%g) in the vicinity of Christchurch for the Christchurch 02/21/11 (M6.3) and Darfield 09/03/10 (M7.0) earthquakes. Station locations are identical where possible; otherwise nearest reported PGA is shown. Values in the last row show average PGA differences (Christchurch – Darfield) and average PGA ratios (Christchurch ÷ Darfield). Data from USGS Shakemaps.
Comparing Ground Motions

The figures on the left compare preliminary ground motions for stations in the Christchurch region observing both the Christchurch and Darfield earthquakes.

Figures courtesy of Brendon Bradley; data from GNS Science, New Zealand.
Darfield Earthquake Aftershock Sequence, 09/03/10 - 02/20/11 (prior to the Christchurch earthquake).

Data from GNS Science, New Zealand
Darfield Earthquake Aftershock Sequence, Time History

Figure modified from J. Donovan & T. Jordan

Data Source: GNS Science, New Zealand
Darfield Earthquake Aftershock Sequence, M: Time History

Date (UTC)

Magnitude (M)

Data Source: GNS Science, New Zealand
Understanding the precise relationship between the two events involves unraveling the complex faulting history of the Darfield earthquake, and how that network of faults relates to the fault that ruptured on 02/21.

This image projects the energy release of all earthquakes in the sequence onto an E-W profile.