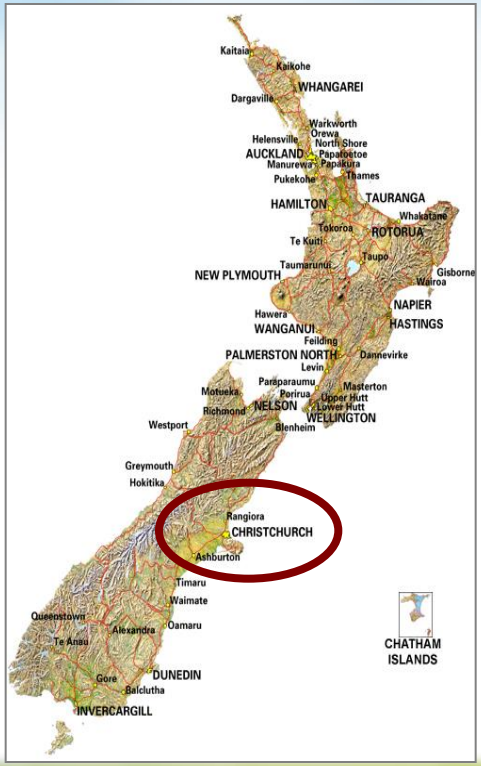
Using GIS to Measure the Impact of the Canterbury earthquakes on House Prices in Christchurch, NZ



Dr's Sandy Bond & Sofia Dermisi

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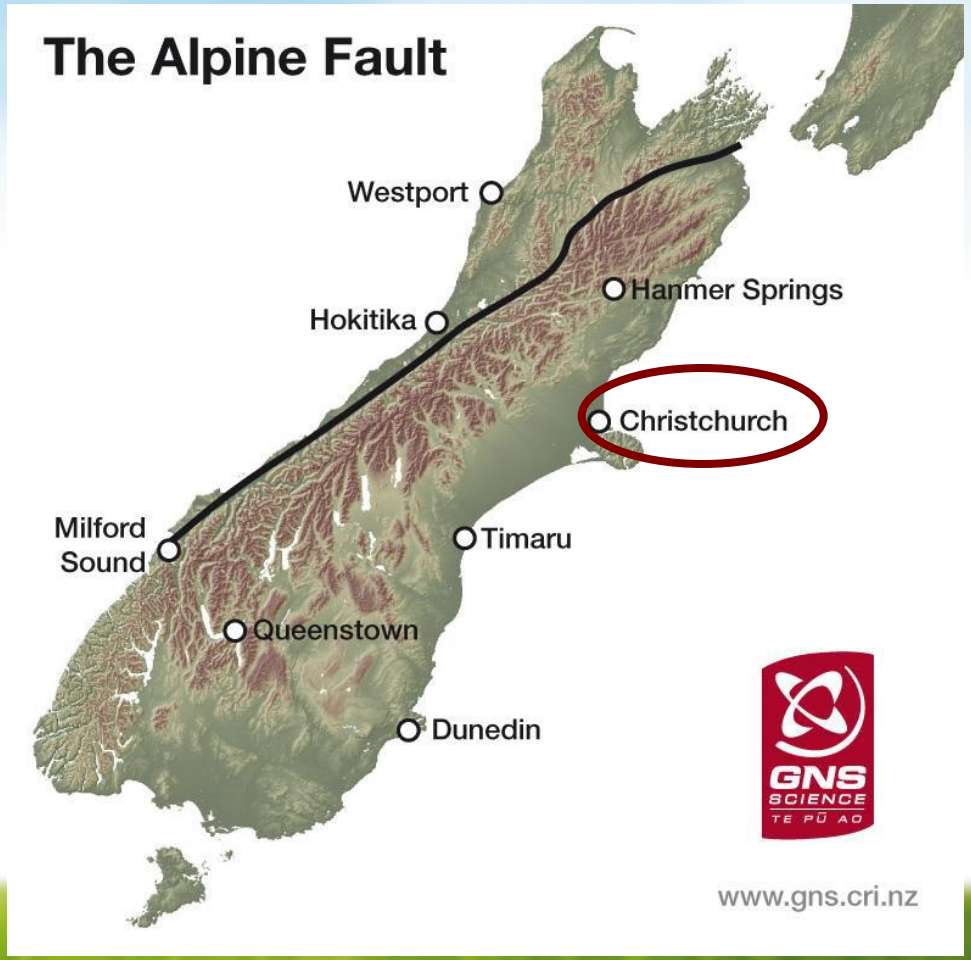
Christchurch was considered a low-risk earthquake city as it is 100km away from the Alpine fault line



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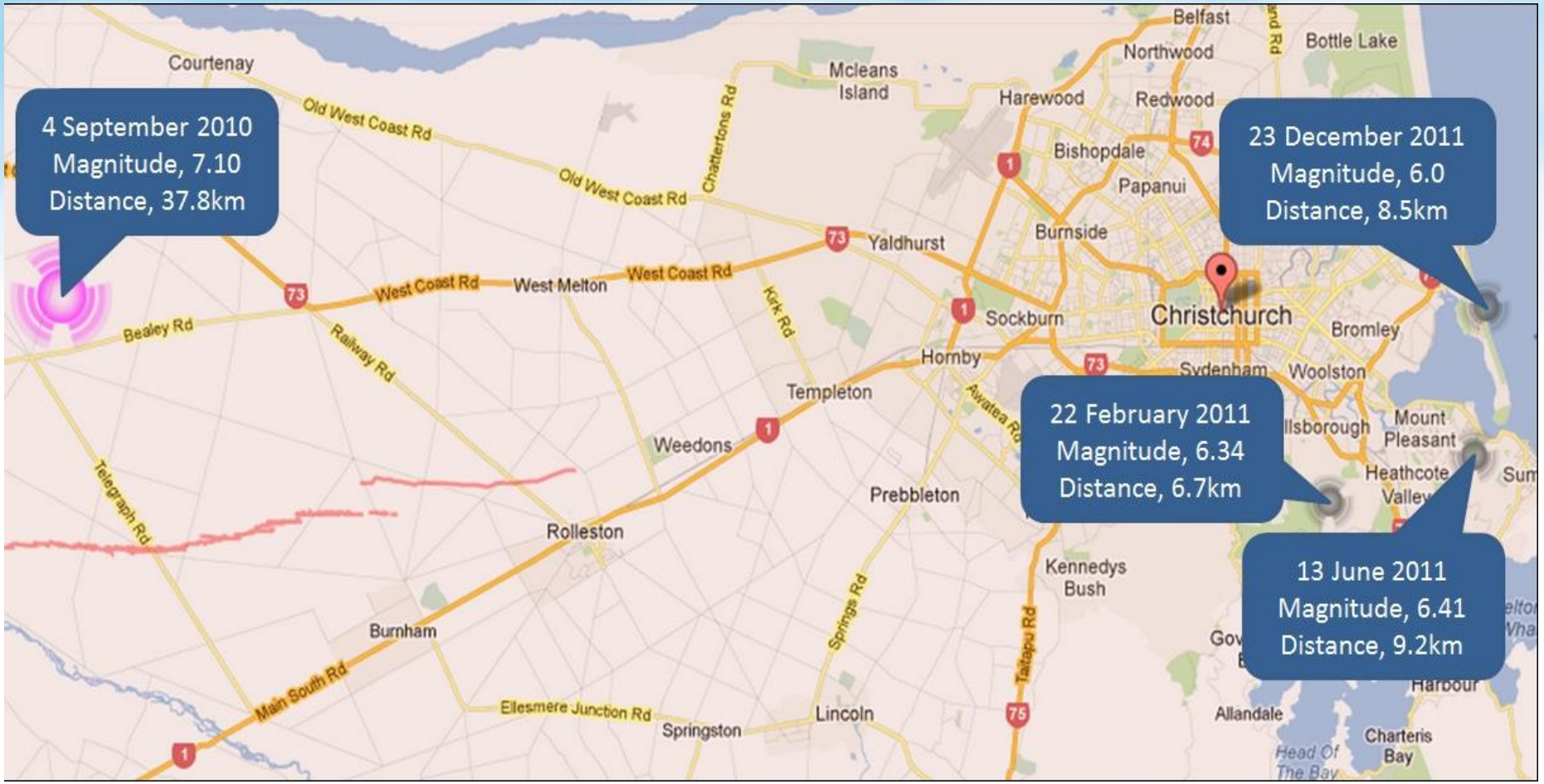
Quake events



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Impacts

- Cost of the quakes: NZ$30 billion +
- Two-thirds of CBD buildings collapsed or unsafe
- 7,839+ Red zone homes
- Liquefaction: land may not be able to be built on (EQC will compensate 400m2)

Impacts

- Significant liquefaction affected the eastern suburbs, producing around 400,000 tones of silt
- Lateral spread caused much of the building damage
- As at 1 March 2013 there have been 528 earthquakes and aftershocks over $4M_W$ since the September 2010 event

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Land Zoning

- The residential land in Christchurch was zoned according to assessments of land & building damage & risk of liquefaction
- The zones are:
  - Green (Go Zone) & include Technical Categories 1, 2 and 3 (TC1, TC2, TC3) where the repair/rebuild process was able to begin
  - Red (No Go Zone) where land repair would be prolonged and uneconomic, and
  - White (Unzoned) that included the CBD or hillside land where geotechnical mapping & further assessment were underway.

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Red Zone

- The Red Zone - approx 7000 homeowners have taken up the government offer to purchase property at the most recent rating valuation
- Due to increased flood risk mostly in the Red Zone and changed land levels assessed through the use of LADAR photography & survey that enabled the ground level/thickness of crust (indicating liquefaction risk) to be estimated
- New flood zone maps were required

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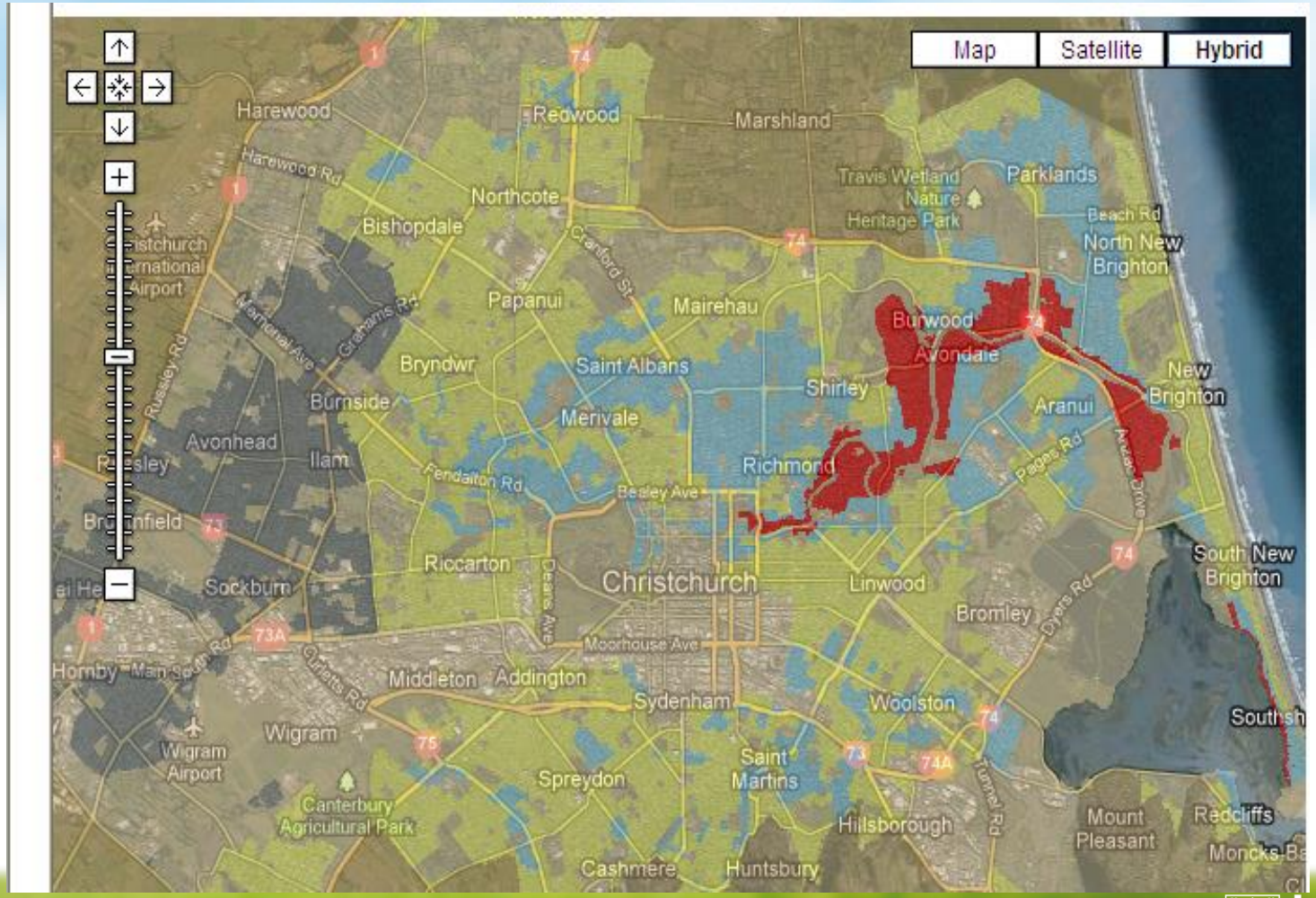
Technical Categories



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Technical Categories

TC1 to TC3:

- Site investigations are required to assess foundation type due to ChCh's variable soils
- Categories **DO NOT** indicate liquefaction hazard
- Many parts of the country require foundation designs to suit ground conditions
  - E.g clay soil in Auckland (shrinkage/expansion)
- **Aim:** appropriately engineered foundations

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Technical Categories

Technical Category 1 (TC1) - grey

- Future land damage from liquefaction is unlikely.

Technical Category 2 (TC2) - yellow

- Minor to moderate land damage from liquefaction is possible in future significant earthquakes.

Technical Category 3 (TC3) - blue

- Moderate to significant land damage from liquefaction is possible in future significant quakes
- **NB: EQC Land Damage Reports** are separate from technical categories

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Background: Stigma

- The concept of environmental stigma appeared in the valuation literature in the late 1980s
- A consistent theme running through the literature of that time was that debt financing was more difficult to obtain for threatened or stigmatised properties
- Anything that changes the publics' perceptions towards risk will alter the degree & duration of stigma
- Changes in public perceptions of risk can also result from media attention.

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Background: Stigma

- When publicity about the hazards has been “intense, ongoing and increasing”, observed levels of measurable property value impact have tended to persist over time
- Market conditions have also been shown to impact on risk perceptions
- Jackson (2001) found that strong market demand reduces, or mitigates, lender & investor risk & weak demand increases, or exacerbates, their risk.

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Research Aim

- Determine residents' perceptions of risk towards owning & living in residential property in Christchurch subsequent to the 2010 & 2011 Canterbury earthquakes

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Data

- All NZ residential transactions 9/2008 – 6/2012 based on the Real Estate Institute of NZ
- Data fields (*house characteristics, land zone types)*
- *Transformations:*
  1. Inclusion of transactions only within Christchurch, Selwyn and Waimakariri
  2. Transaction geocoding matching
  3. Extraction of homogenous housing types for analysis
  4. Use of ValBiz sales data in updating missing housing characteristics
  5. Integration for statistical analysis purposes
  6. Separation of sale timing as before/after the two earthquakes 9/4/10, 2/22/11
  7. Data cleaning from mislabelling (e.g. for land area, sale price etc.)
- *Transformed dataset includes:* 12,379 house

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Methodology

A three-step approach is used:

a) an average trend analysis between and within the three land zones (TC1 to TC3),

b) GIS hot-spot analysis to identify possible spatial differentiations between the before & after effects of the earthquakes, and

c) hedonic modeling to quantify the effect of house characteristics on sale price while controlling for and comparing, three land zones (TC1 to TC3).

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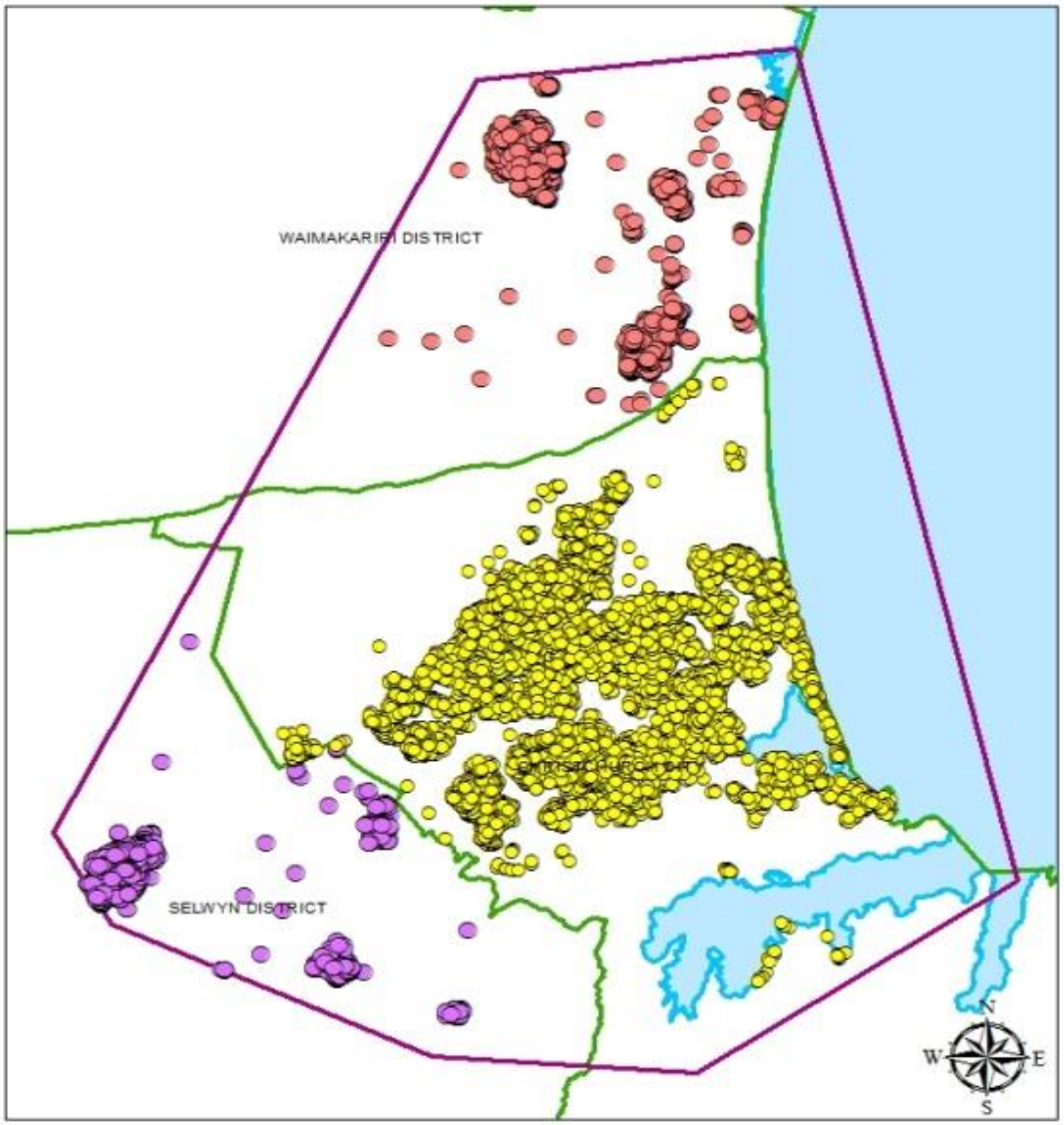
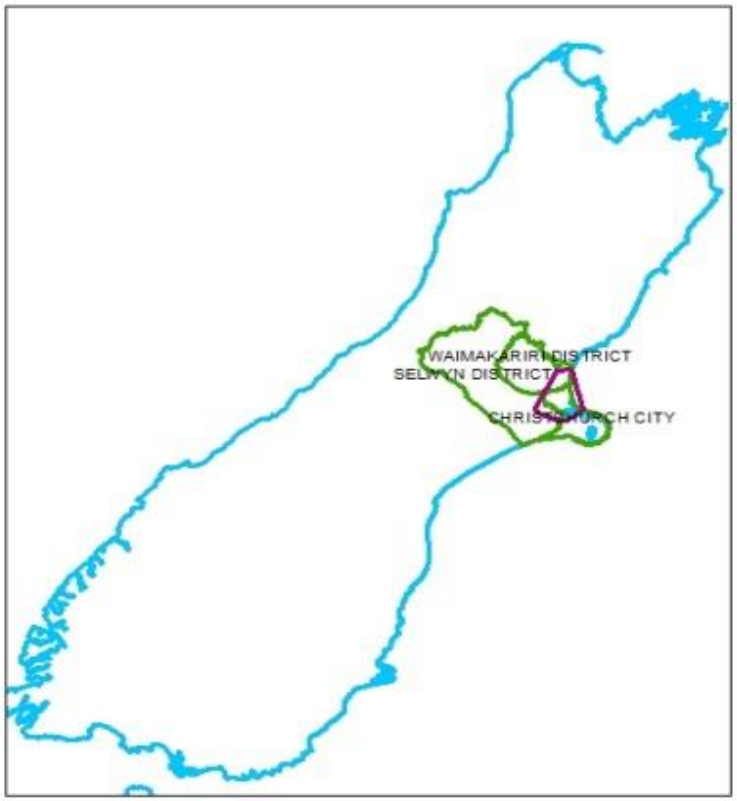
Study Area with home locations





Legend

- Christchurch
- Selwyn
- Weimakariri
- Study Area
- District Boundaries
- NZ Coastline

Study Area in Selwyn

Figure 3a. Houses sold before the 9/4/10 quake

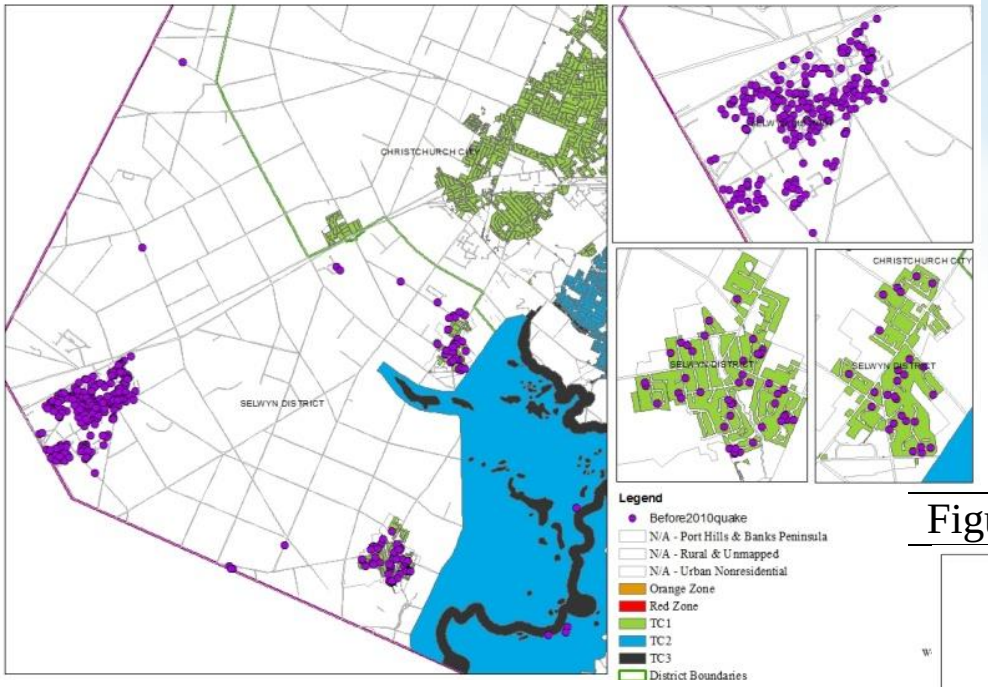
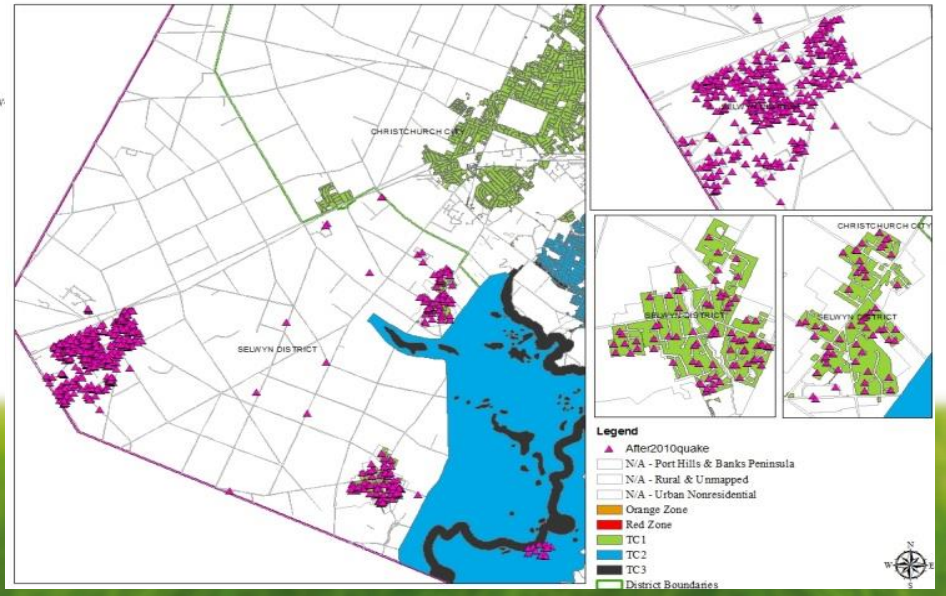


Figure 3b. Houses sold after the 9/4/10 quake



Study Area in Selwyn

Figure 3c. Houses sold before the 2/22/11 quake

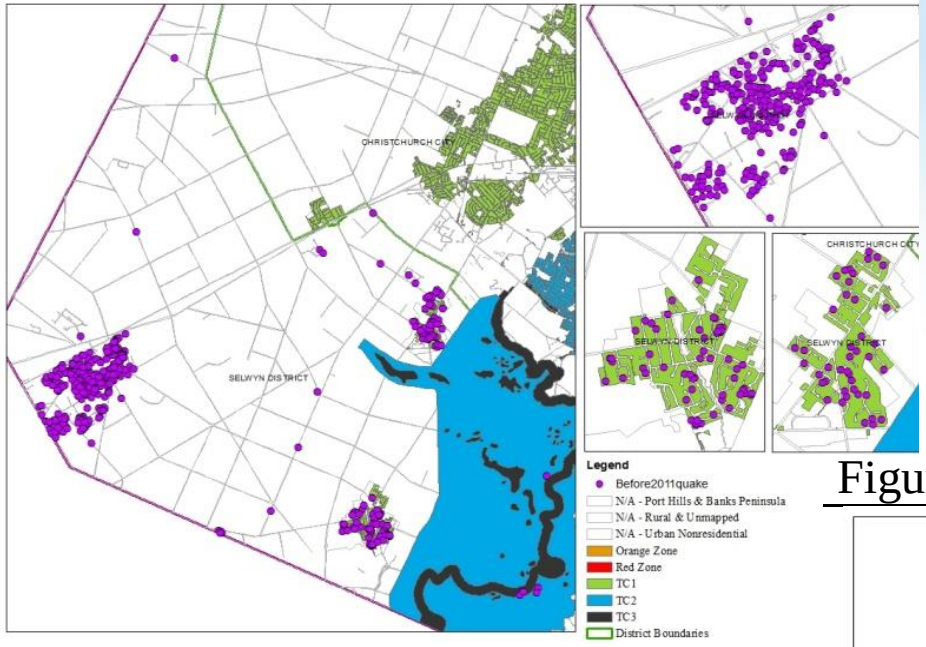
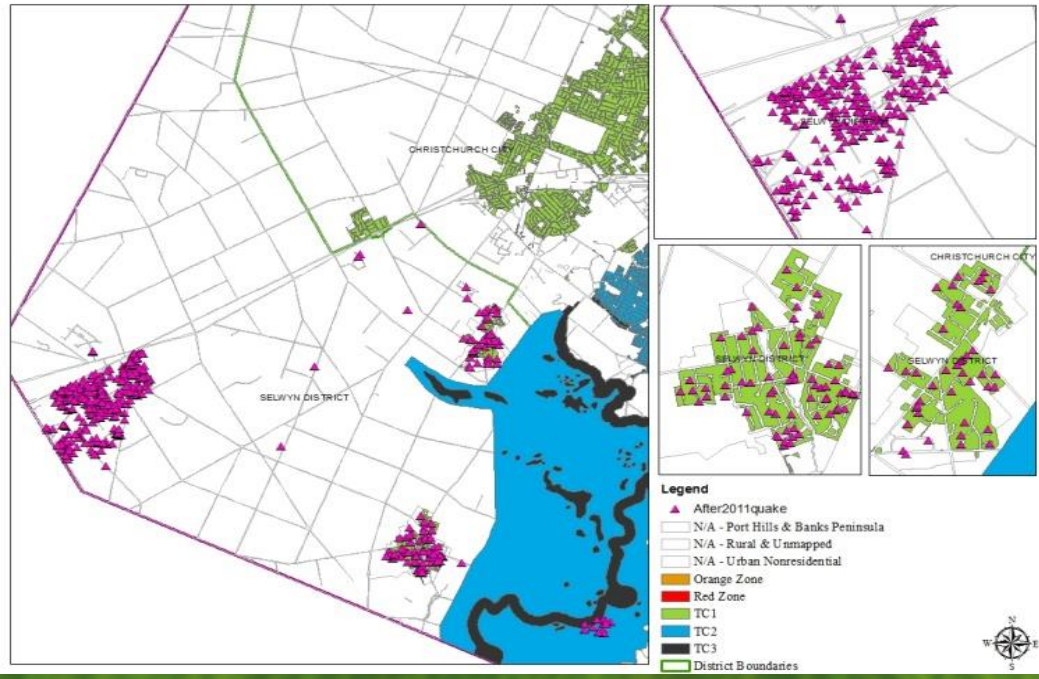


Figure 3d. Houses sold after the 2/22/11quake



Study Areas in Waimakariri

Figure 4a. Houses sold before the 9/4/10 quake

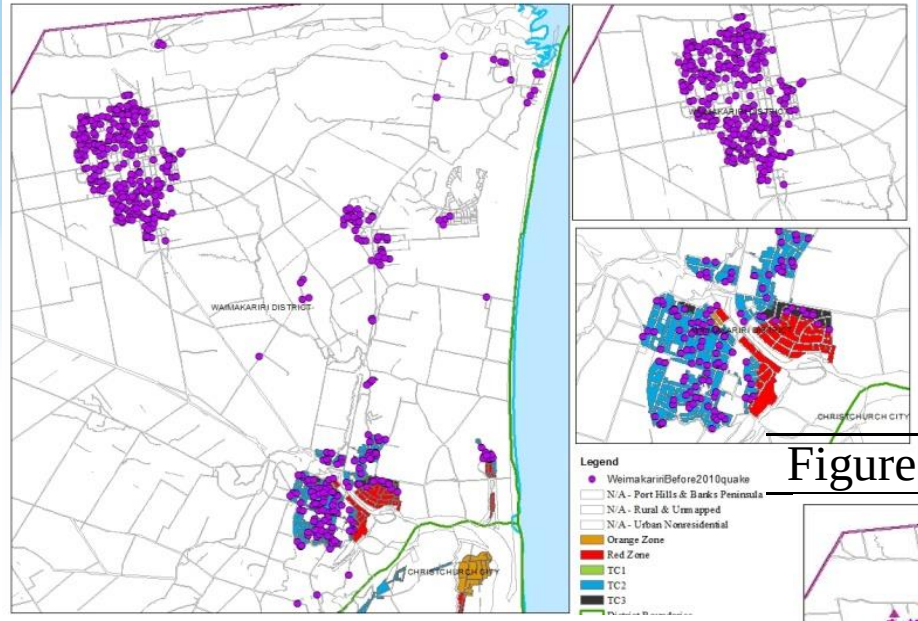
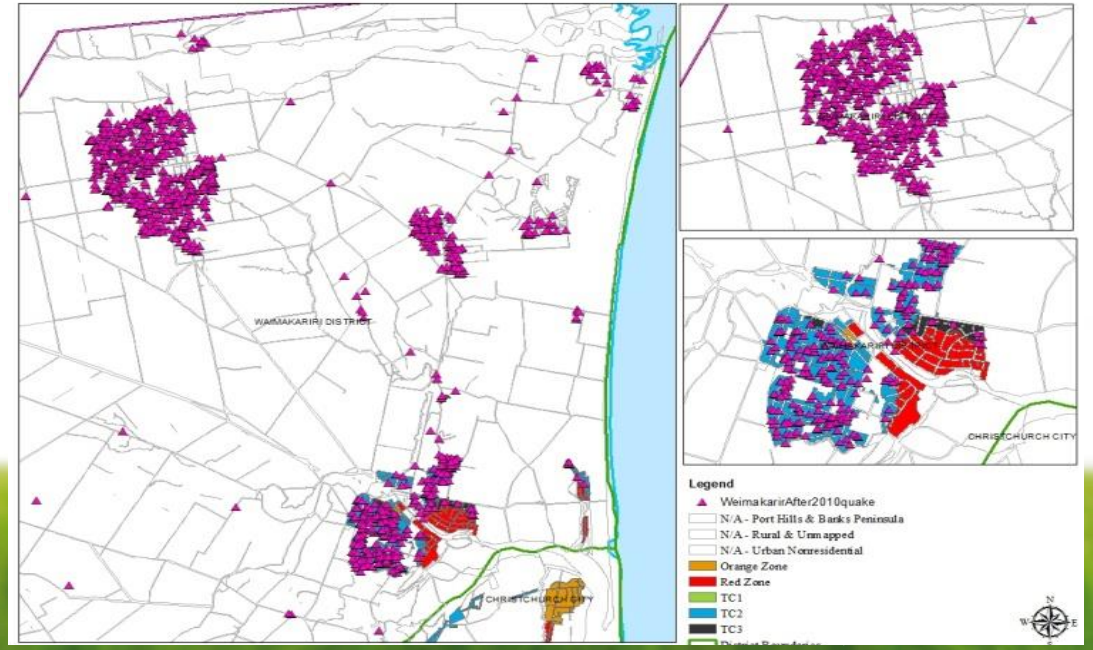


Figure 4b. Houses sold after the 9/4/10 quake



Study Areas in Waimakariri

Figure 4c. Houses sold before the 2/22/11 quake

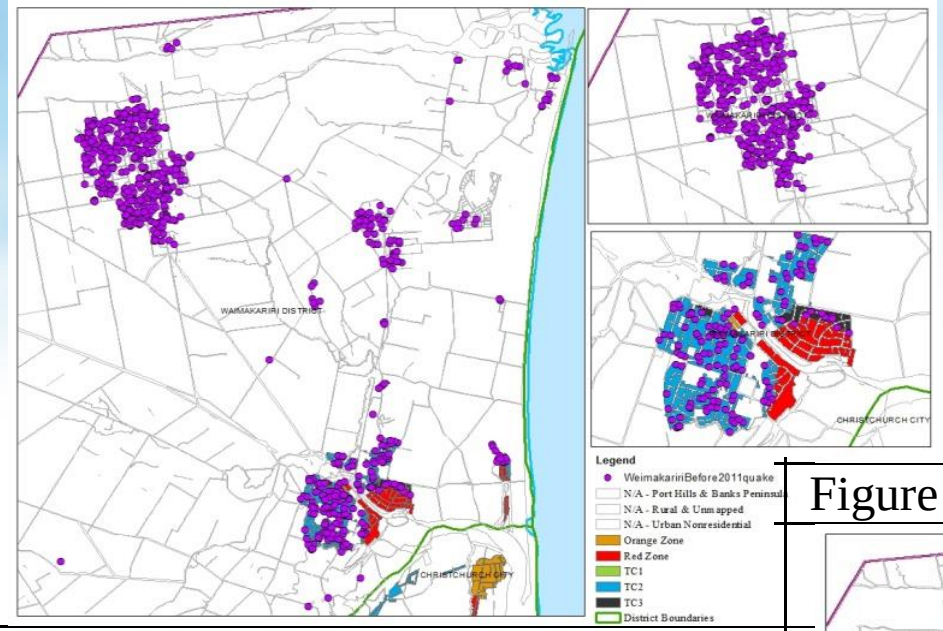
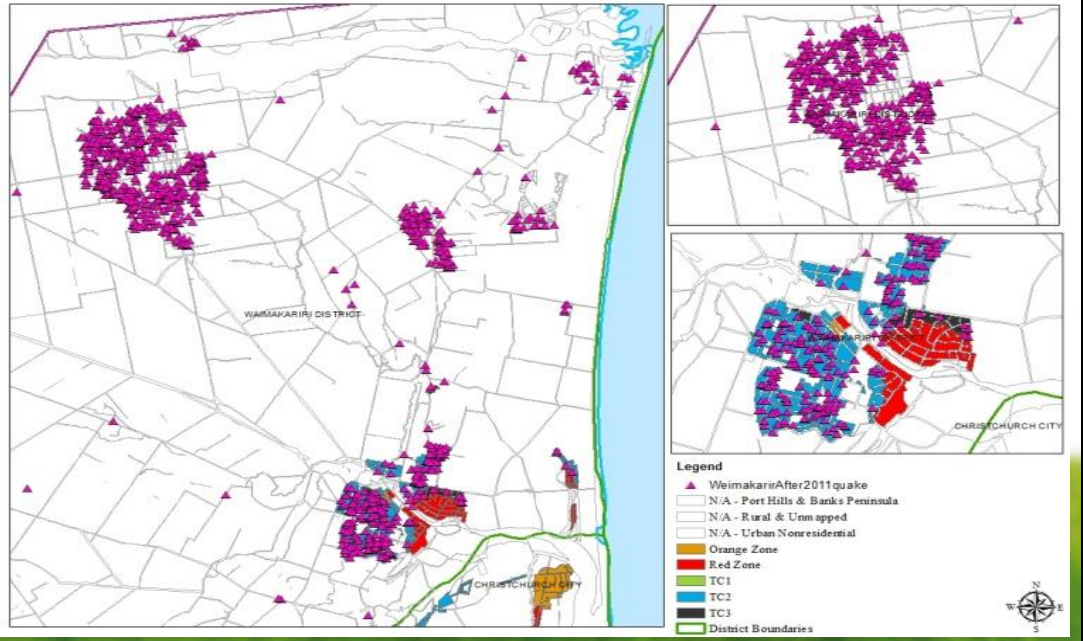


Figure 4d. Houses sold after the 2/22/11quake



Results – part 1

- **Assessment of all areas**
  - Sale prices ↑ on average after both quakes for newer and larger houses, with sell days ↑ after the first quake
  - Sale price ↑ after both quakes in the TC1 and TC2 areas
  - TC3 area sale prices are not affected on average by the quake => less negative property value effect regardless of the negative media attention

- **Christchurch**
  - Above overall results were maintained

- **Selwyn & Waimakariri**
  - Sale price trend is maintained after both quakes

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Results – part 2

- Assessment of each of the three areas before & after the two quakes suggests:

- **Christchurch**
  - Clusters of similar valuations exist northwest & south of the downtown but without a significant difference between the quakes
- **Selwyn**
  - Differences exist between the before and after second quake valuation trends mainly in one of the TC1 zones
- **Waimakariri**
  - Differences exist between the before and after second quake valuation trends mainly in one of the TC2 zones

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Results – part 3

Assessing the effect of building characteristics on sale prices:

- Higher sale prices are experienced by:
  - Newer houses; those with more bedrooms, and larger land area. This trend is maintained after both quakes.
  - Newer sale agreements after the quakes (indicative of the: i) need for housing after the quakes, ii) resilience for surviving quality housing after the quakes even within each zone).
  - Mixture of materials and roughcast exterior facades showed more resilience compared to other material

- Decrease in sale prices are experienced by:
  - Newer sale agreements but before the quakes
  - Houses with fibrolite in their exterior façade after both quakes and tile on their roof

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Summary & Conclusions

- Sale prices increased on average after both quakes in the overall dataset as well as within land zones TC1 & TC2, but TC3 did not show differentiation after the two quakes
- The hot-spot analysis indicates the existence of clusters of similar values within Christchurch, Selwyn and Waimakariri which do not change significantly after either of the quakes. The only exceptions being one of Selwyn's TC1 zones after the second quake and one of Waimakariri's TC2 zones after the second quake.

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Summary & Conclusions

- Newer houses achieved higher sale prices before and maintained the same trend after both quakes across all land zones
- Considering the significant negative media coverage, especially among TC3 zones, the results suggest resilience to major shifts and reliance on a building's construction timing (accounting for newer anti-seismic structures).
- TC3 zones, however, experience a sale price decrease for sales agreements after the second quake

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