Residential Building Fragility due to Liquefaction Induced Ground Surface Movement

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Recovery from disaster

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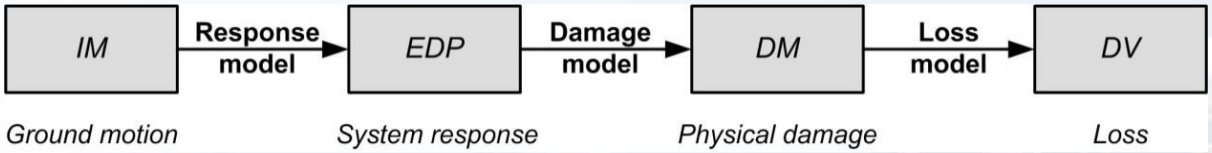
- Predicting financial earthquake losses
- Estimating liquefaction-related losses
  - Before an earthquake
  - After an earthquake
- Optical image correlation
- Example – Canterbury Earthquake Sequence (CES)

Predicting Economic Earthquake Losses

General Approach



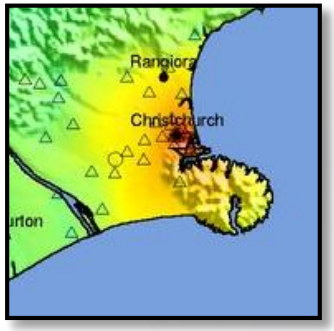
For Shaking Damage

Acceleration → Inter[illegible]y drift → Damage state → $$$, Recovery Planning

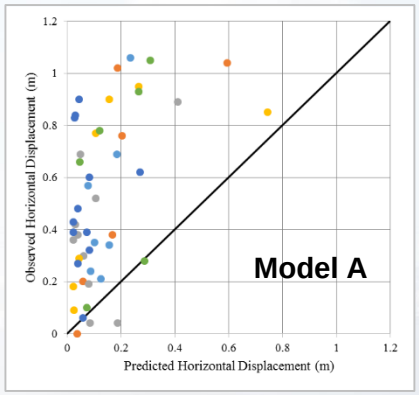
For Liquefaction Damage

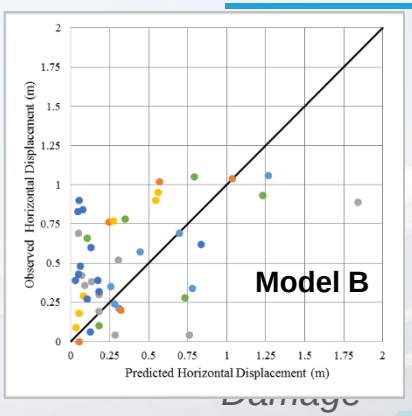
Ground movement → Building / Infrastructure response → Damage state

Estimating Liquefaction-Related Losses – BEFORE EQ



Acceleration



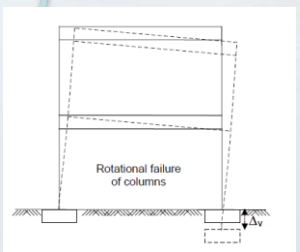


Damage state

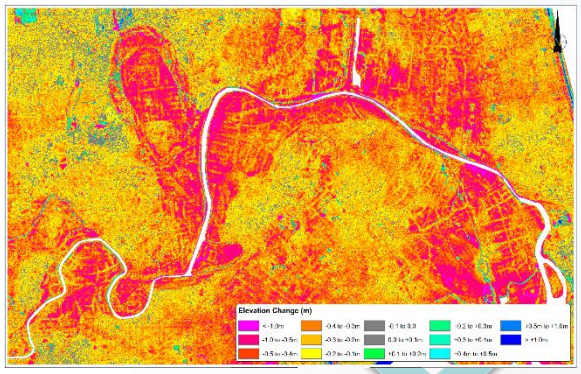
$$$, Recovery Planning

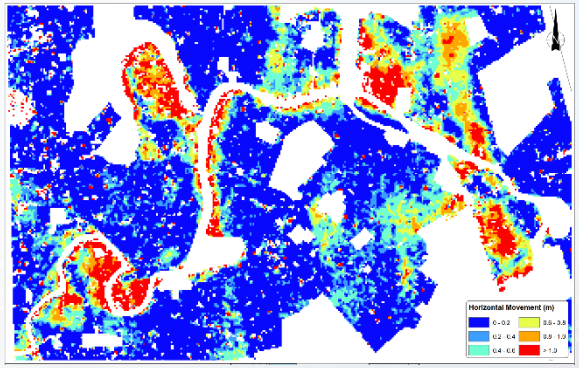
Ground movement

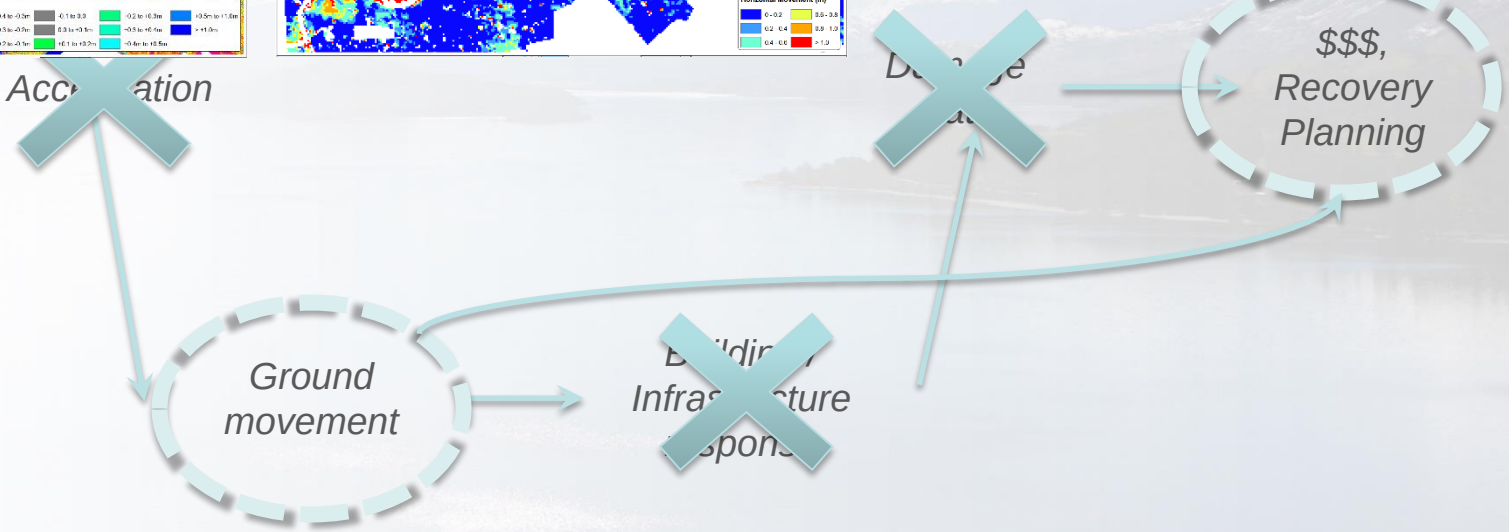
Building / Infrastructure response



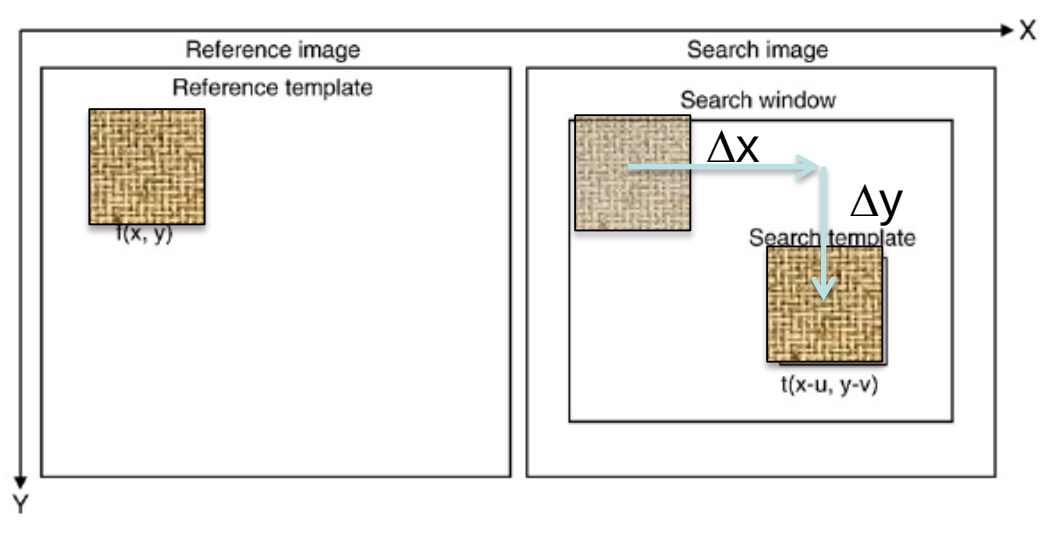
Estimating Liquefaction-Related Losses – AFTER EQ





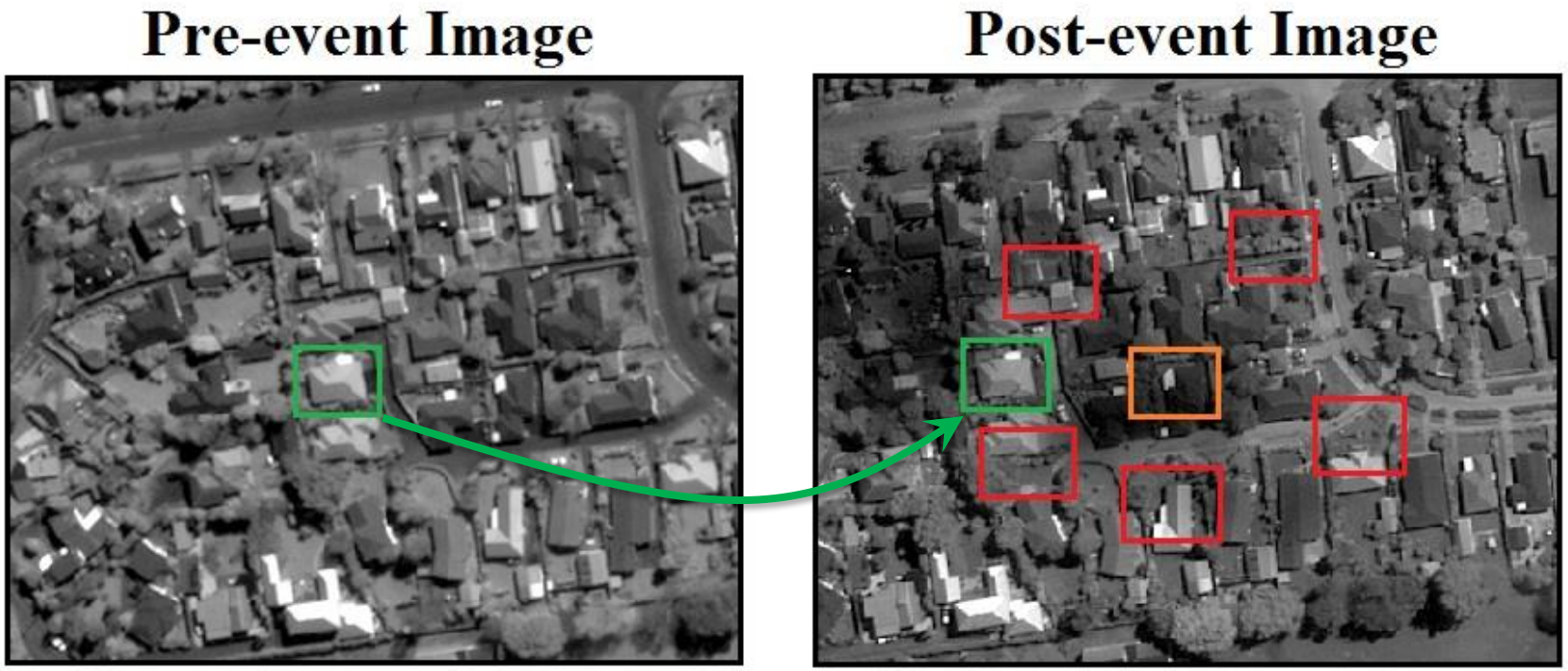


Optical Image Correlation

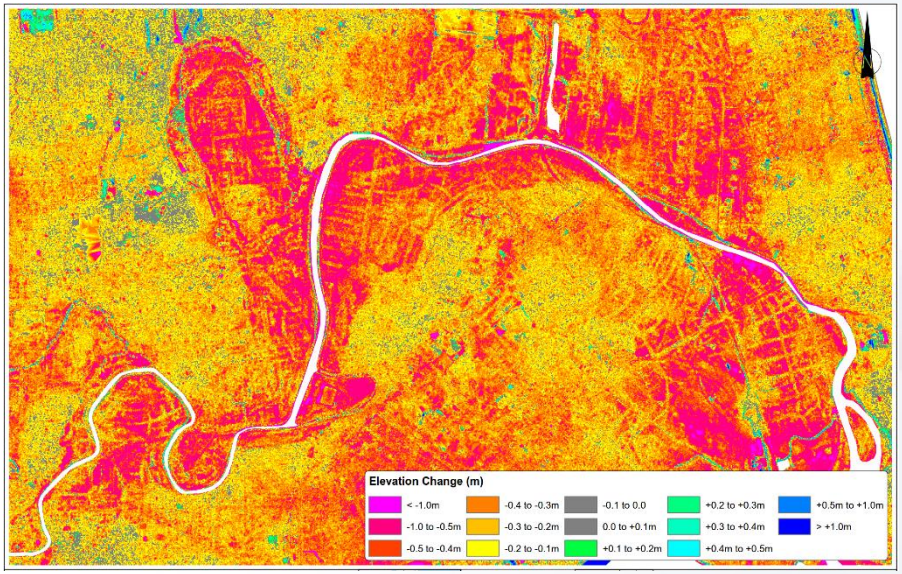


Reference Image **Search Image**

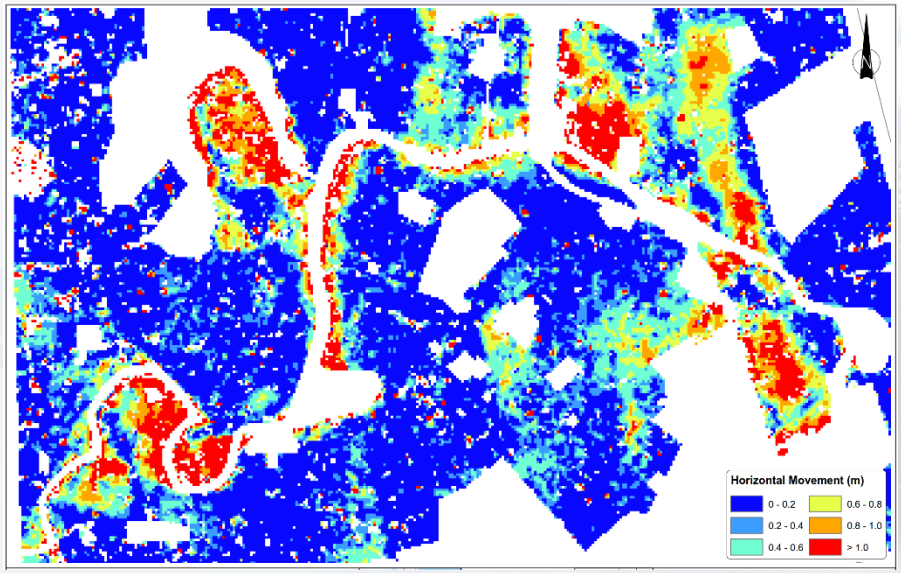
Optical Image Correlation – Co-Registration



CES – Ground Movements



Vertical Movement

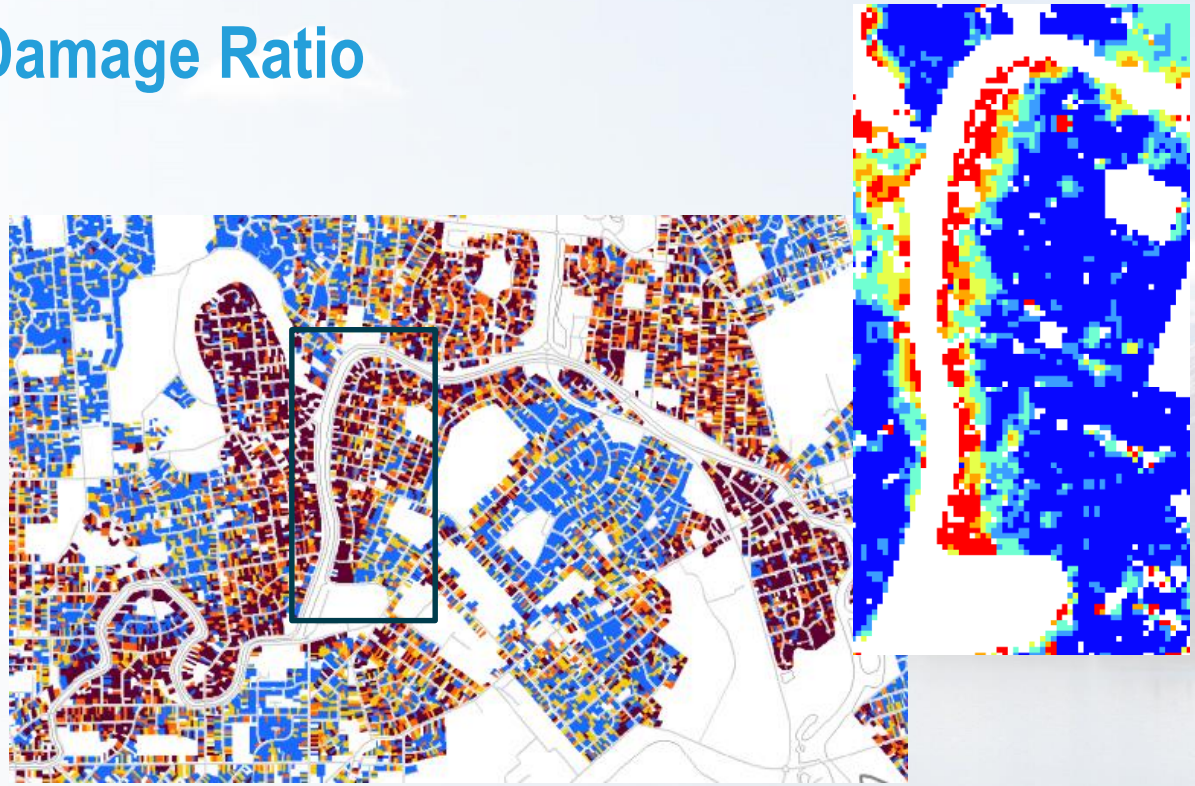


Horizontal Movement

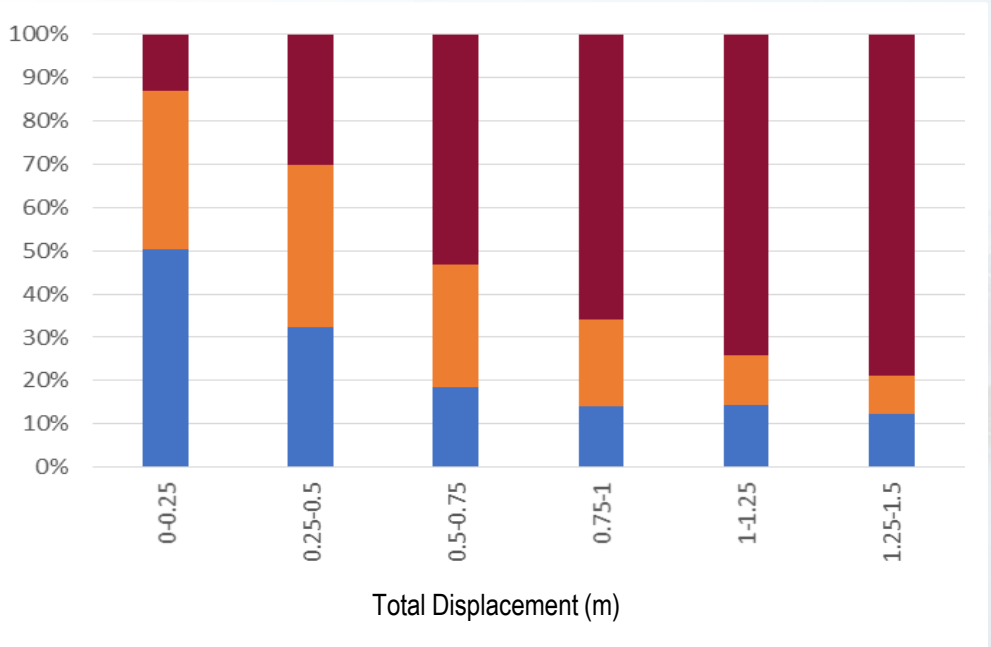
CES – Building Damage Ratio

Building Damage Ratio

- < 0.2
- 0.2 to 0.5
- > 0.5



CES – Total Liquefaction-Related Displacement Correlations



(maximum of the vertical or horizontal liquefaction related movement)

Conclusions

- **Before an earthquake**
  - Use ground motion prediction equations predict ground shaking
  - Use empirical equations to predict ground deformation
  - Use correlations to predict building and financial losses
  - Lots of uncertainty ☹
- **After an earthquake**
  - Measure ground surface deformations
    - Horizontal (Satellite imagery or LiDAR)
    - Vertical (LiDAR) – requires pre event LiDAR
  - Use correlations to forecast building and financial losses
  - Less uncertainty ☺

Thank you