Lateral Spreading Displacements Challenges: Data and Predictive Models

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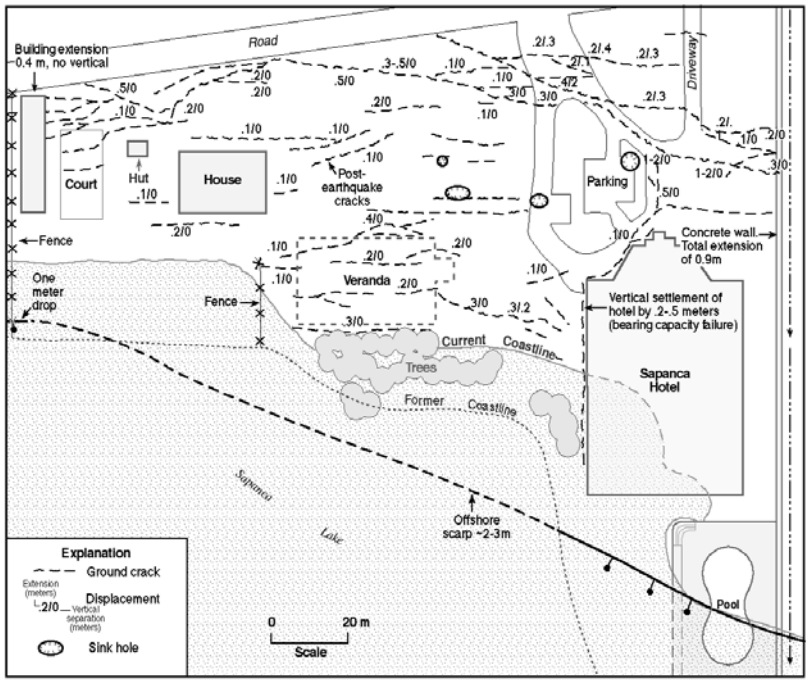
Lateral Spread Displacements

Christchurch EQ

Robinson et al. (2011) *9th Pacific Conference on EQ Eng*

Kocaeli EQ



Hotel Sapanca, Sapanca Lake

Challenges

- Available case history datasets
- Predictive models

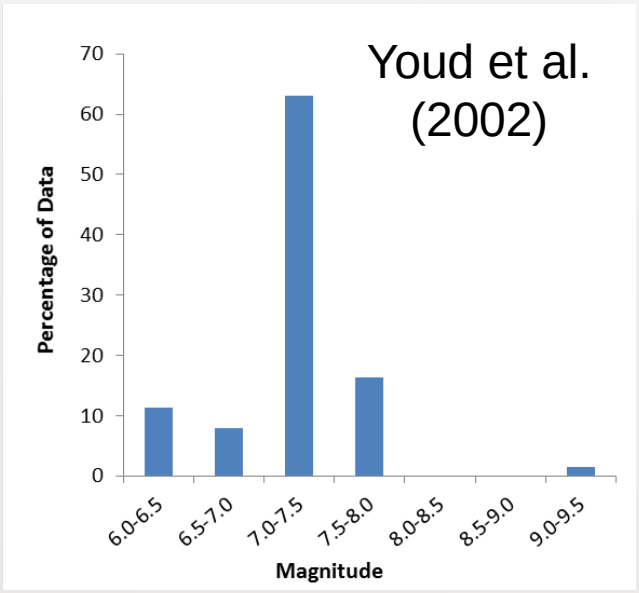
Available Case History Datasets

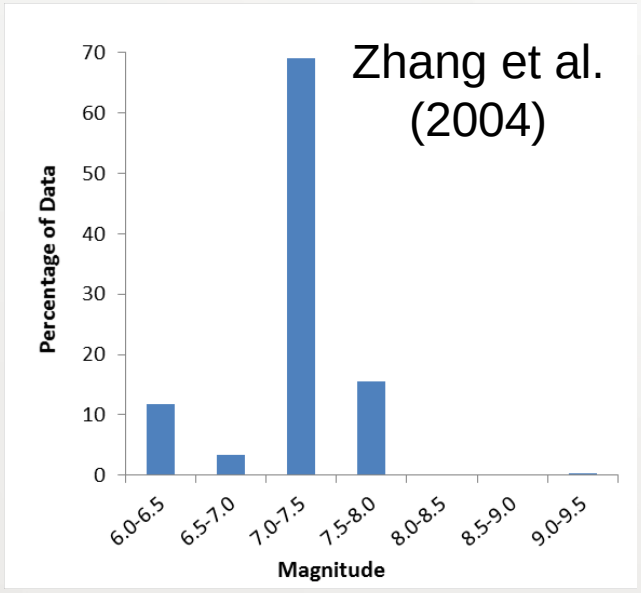
General Characteristics of Datasets

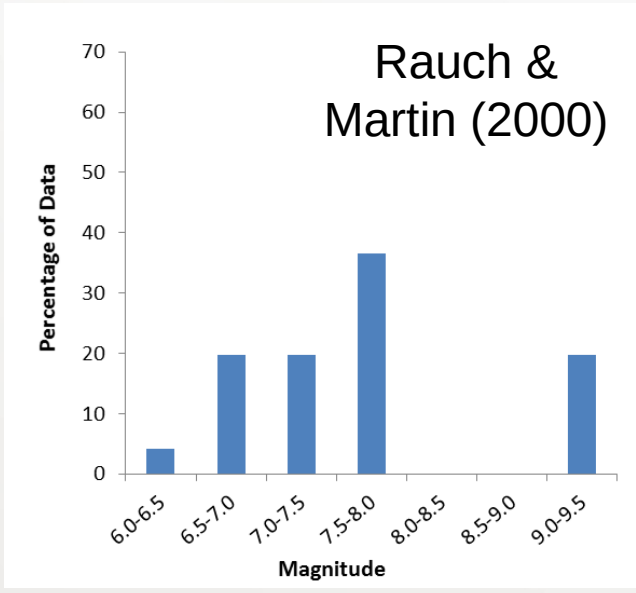
	No. Disp	No. Sites	No. EQs	Niigata EQ
Youd et al. (2002)	450	55	10	300 disp 14 sites
Zhang et al. (2004)	291	21	13	201 disp 6 sites
Rauch & Martin (2000)	71	71	15	14 disp 14 sites

Available Case History Datasets

Magnitude Distributions

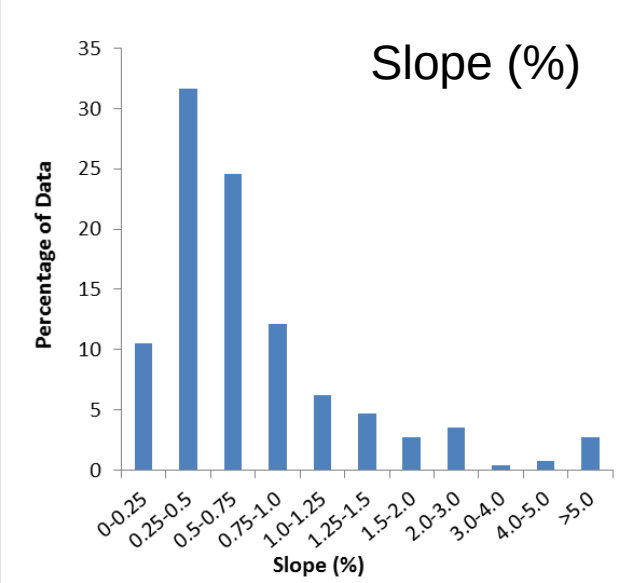


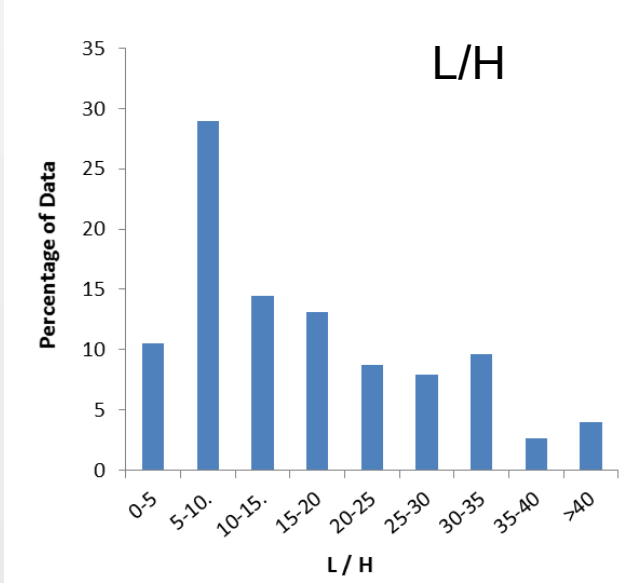




Available Case History Datasets

Youd et al. (2002)





Zhang et al. (2004)

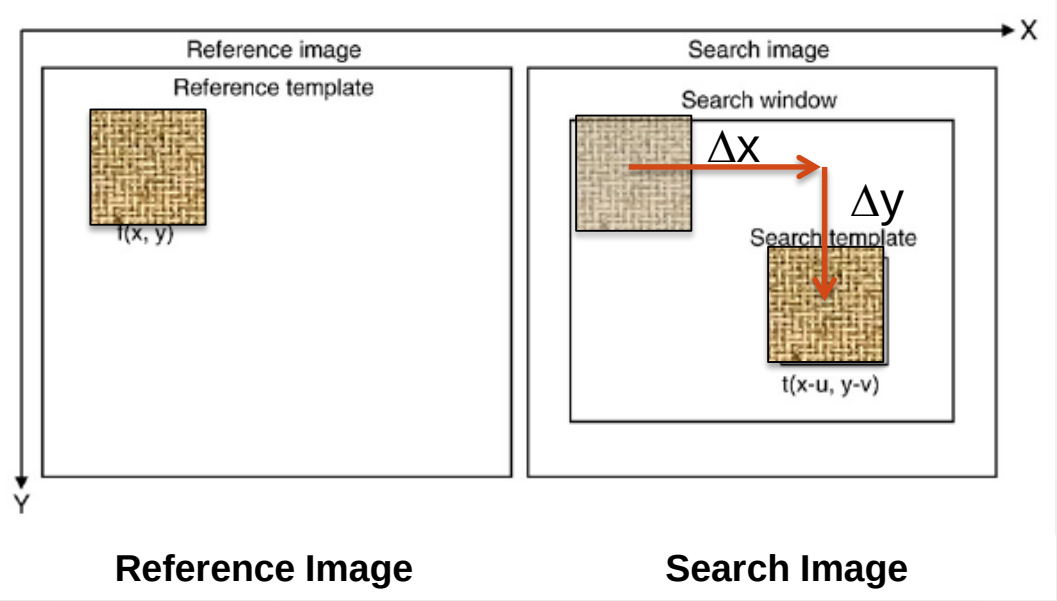
- L/H = 4-40
- Slope 0.2 to 8%

Rauch (1997)

Increasing Available Datasets: Remote Sensing

Two-dimensional Differencing of Imagery

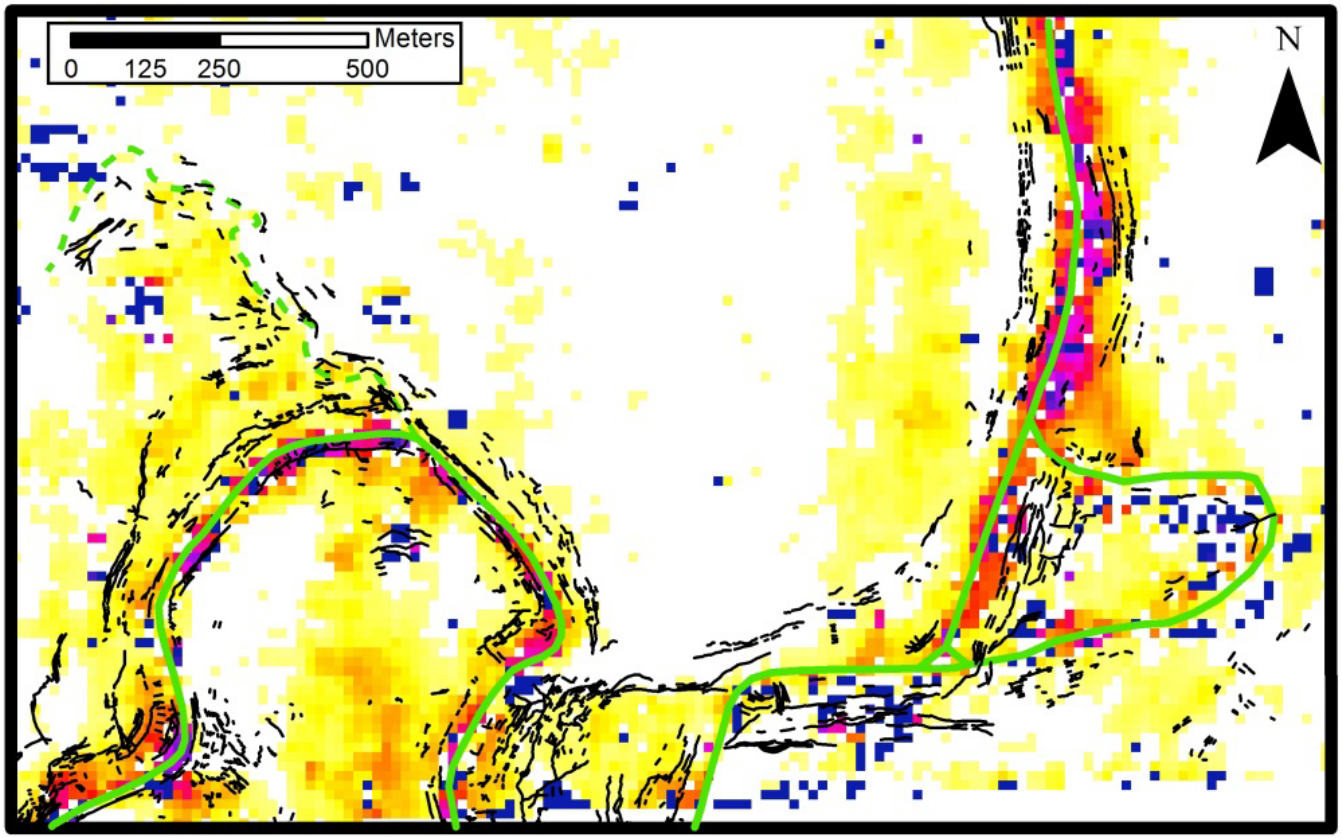
- Measure offsets of chips of pixels between two images
- Corrections for topography, acquisition geometry, etc. required
- Sub-pixel displs can be achieved



Modified from Debella-Gilo and Kaab (2011)

Application to Christchurch EQ

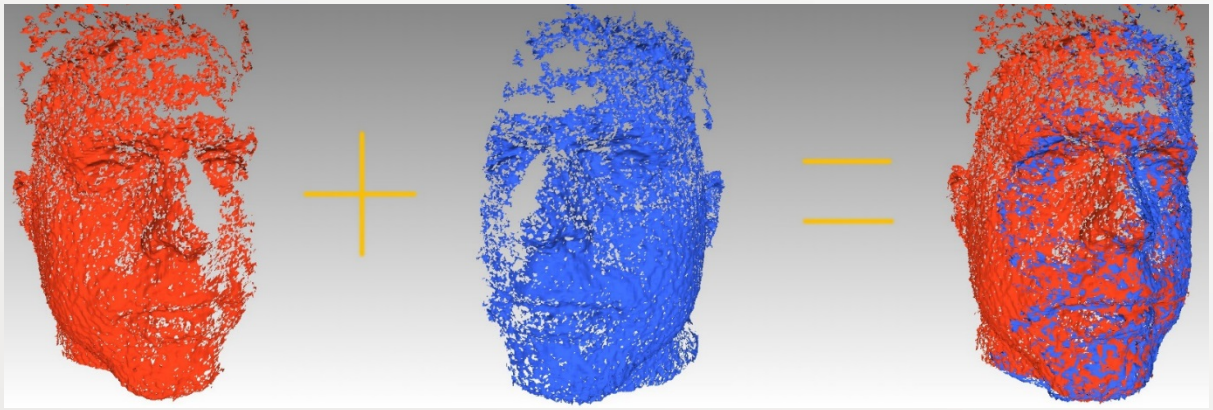
2D Differencing of Satellite Imagery



Martin (2014) *MS Thesis*, Martin and Rathje (2014) *10NCEE*

Increasing Available Datasets: Remote Sensing

Three-dimensional Differencing of Point Clouds



http://dynface4d.isr.uc.pt/database.php

- Iterative Closest Point (ICP): co-registration of point clouds
- Can be used on patches within 2 co-registered point clouds to measured 3D displacement
- Requires “terrain texture” in the point cloud, large point density, etc.

Lateral Spreading Models

W = H/L

Rauch (1997)

Sloping Ground ***Free Face***

Youd et al. (2002), Bardet et al. (2002), Gillins and Bartlett (2014)

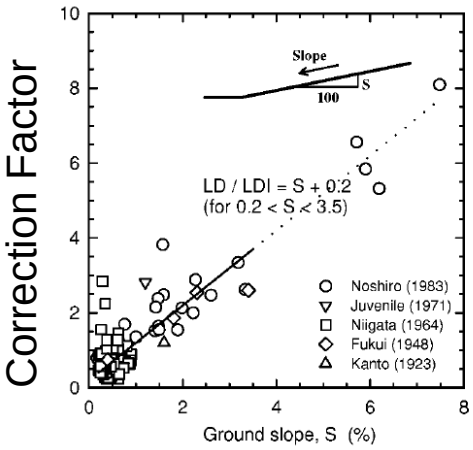
- Empirical regression models
- Treat each displacement as independent
- D = fxn (M, R, T_{15}, slope or W, FC, D_{50})
- T_{15}=cumulative thickness of N < 15 material

Lateral Spreading Models

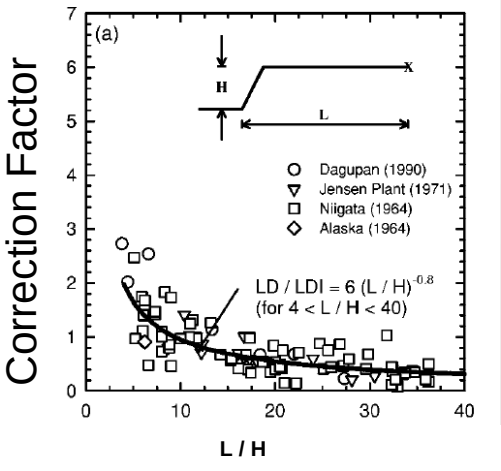
Zhang et al. (2004)

- Semi-empirical model
- Based on induced γ_{max} and empirical correction factor
  - LDI = $\left[\int \gamma_{max} \cdot dz \right]$
  - γ_{max} = fxn (FS_{liq}, D_R)
  - D = LDI · $Correction\ Factor$
- Treats each displacement as independent to develop correction factor

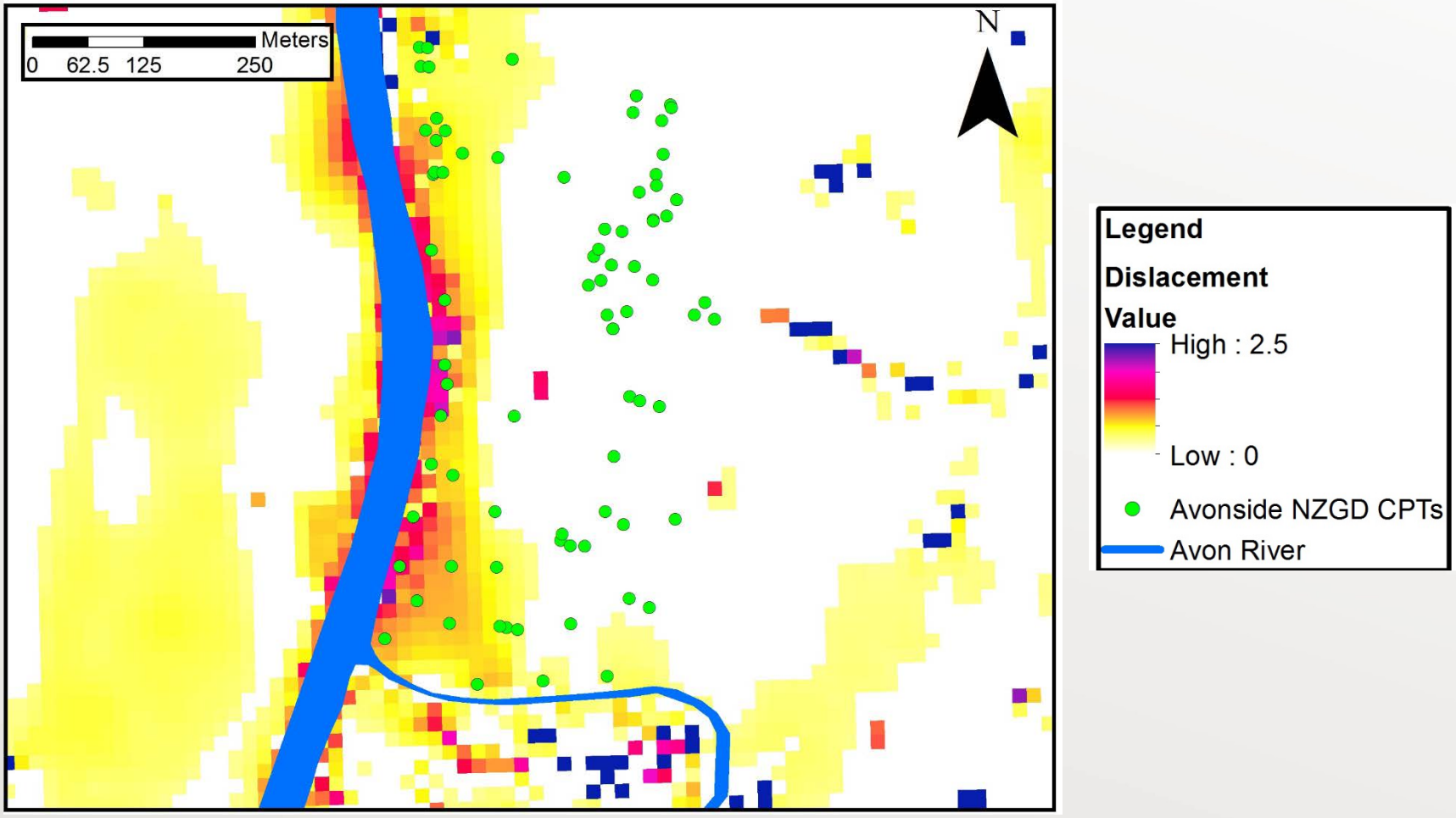
Sloping Ground



Free Face

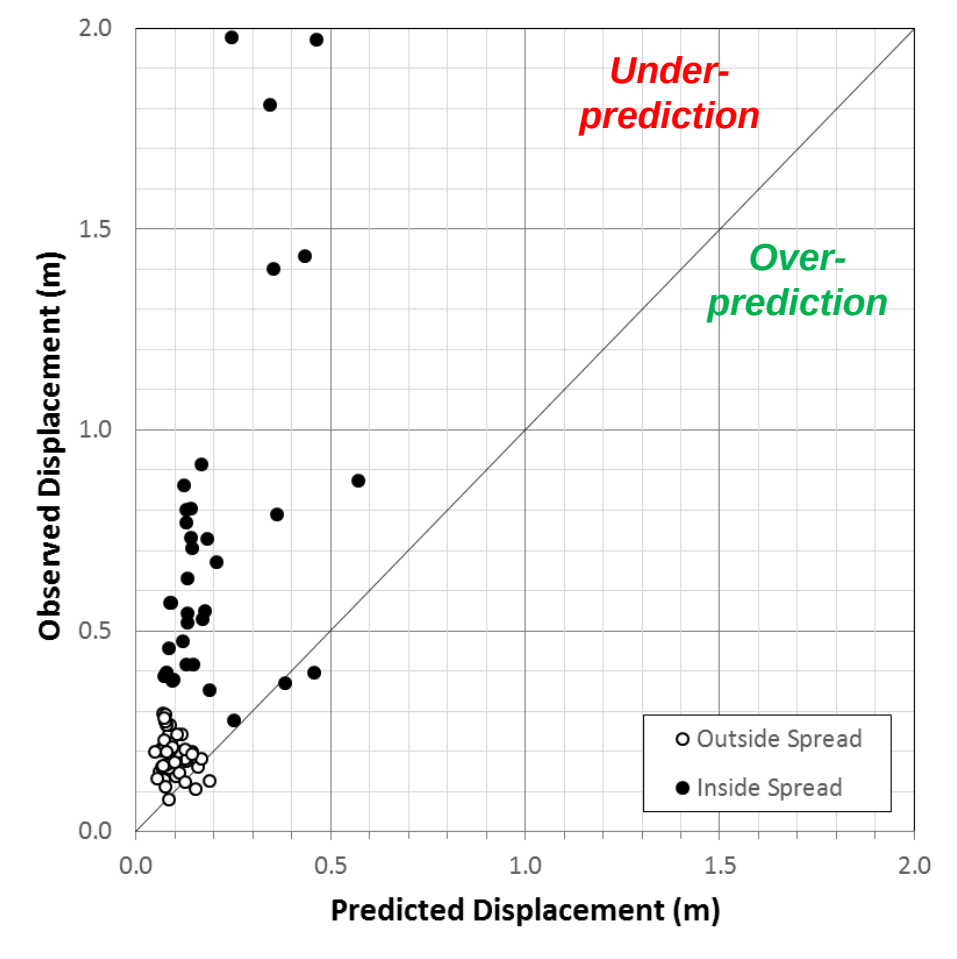


Avonside Loop, Christchurch



Youd et al. (2002)

Observed vs. Predicted

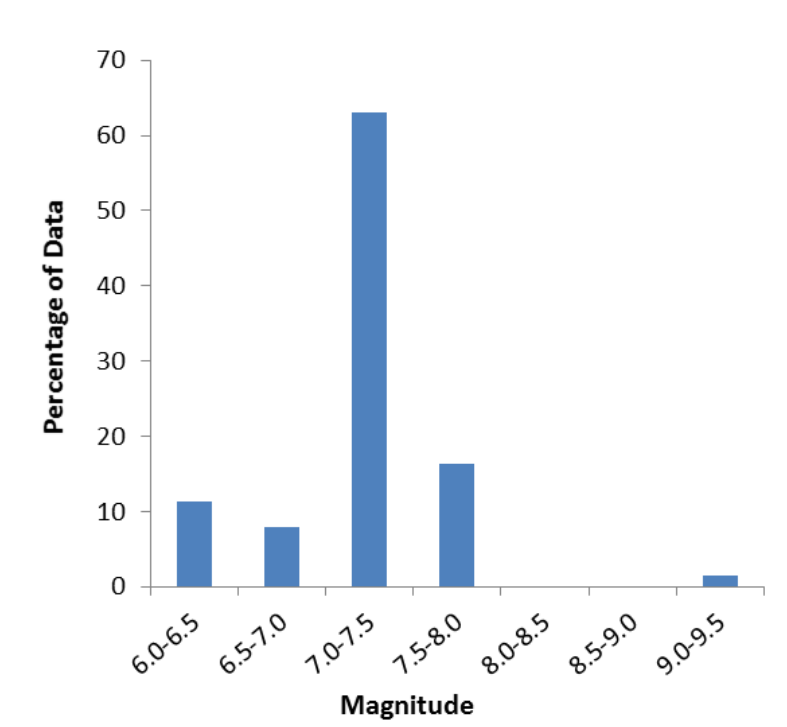


- General under-prediction
- Consistent under-prediction for L/H > 15 (H ~3.5 m)
- Similar results for Bardet et al. (2002), Gillins & Bartlett (2014) models

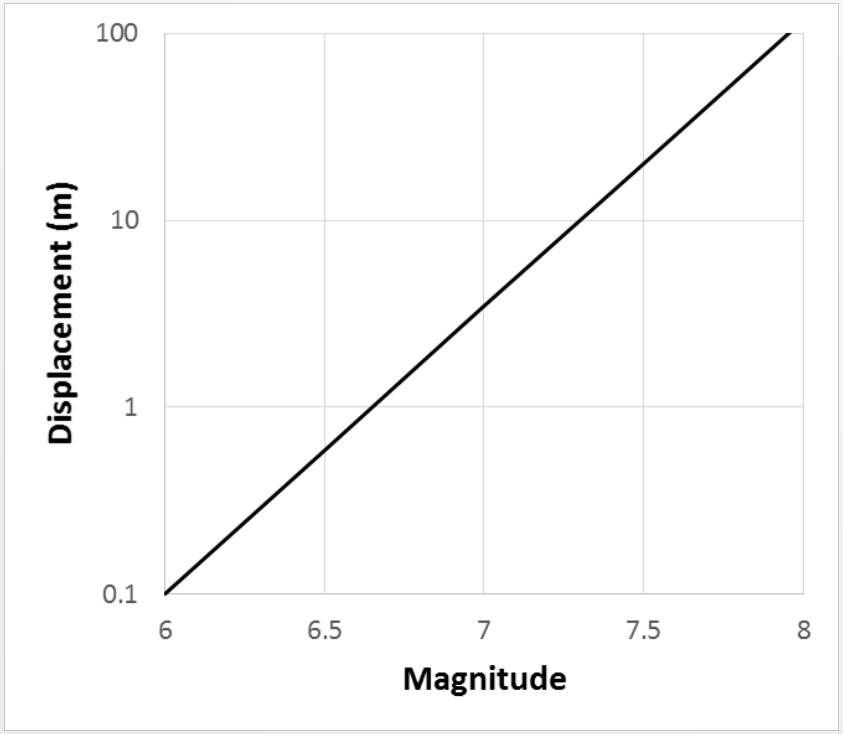
Assumed: FC = 20%, D50 = 0.2 mm

Magnitude Scaling

Youd et al. Dataset



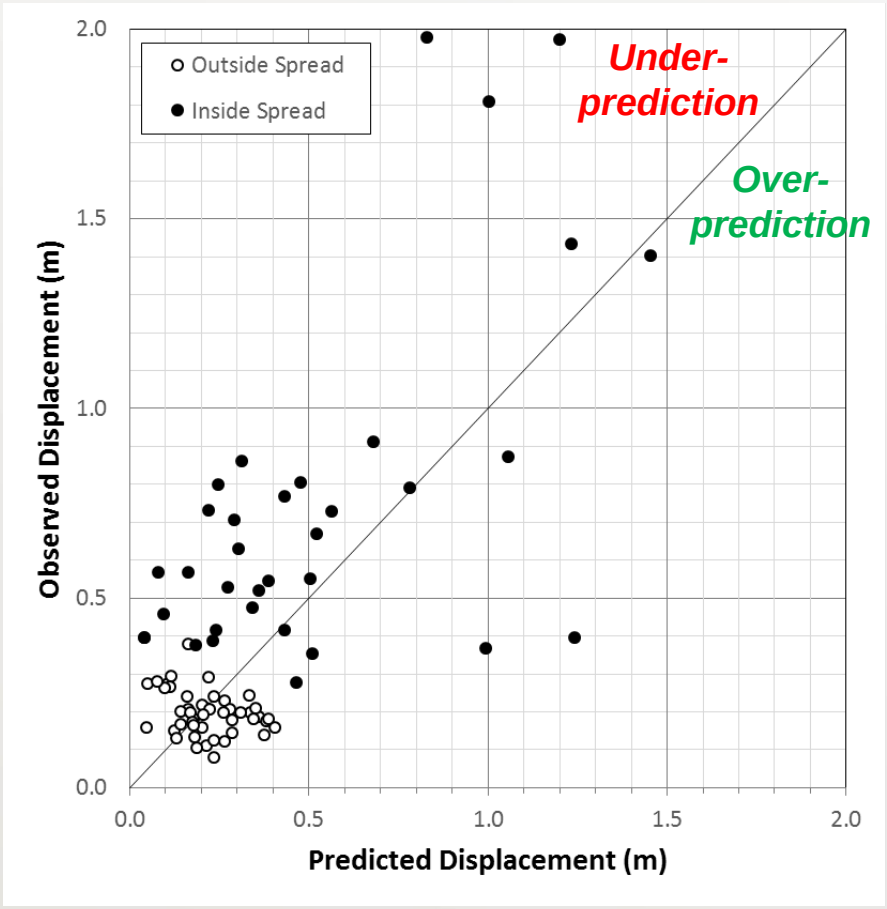
Magnitude Scaling



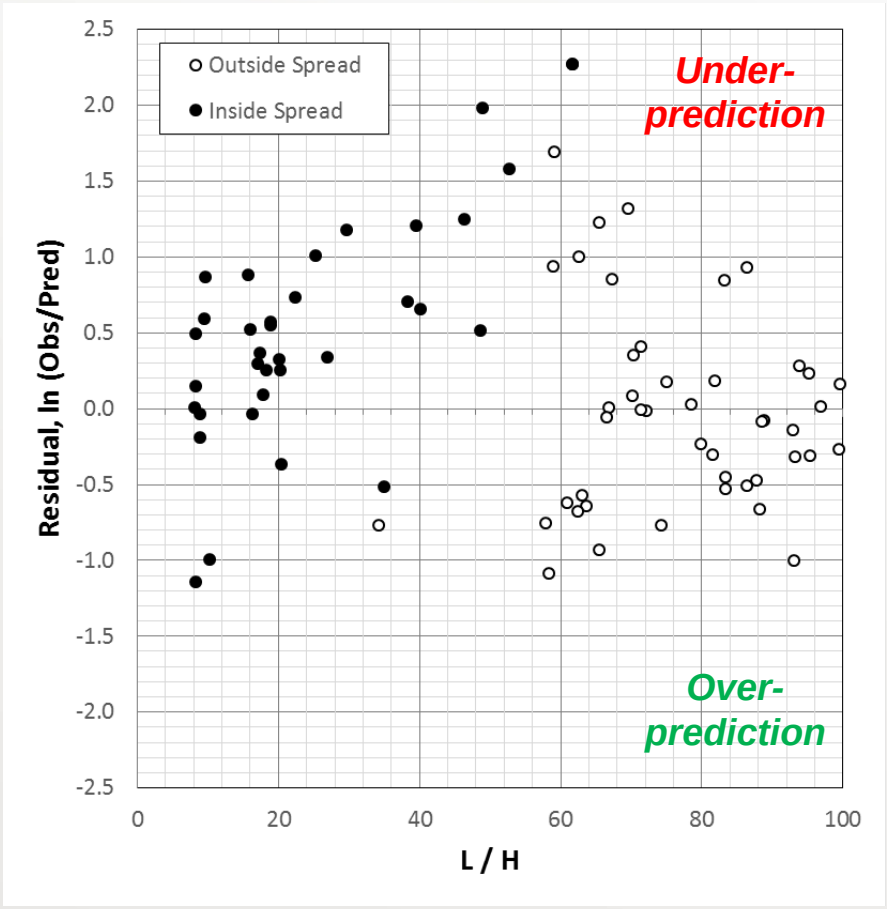
Assumed: T_{15} = 3 m, W = 5%, FC = 10%,
D_{50} = 0.3 mm, R = 5 km

Zhang et al. (2004)

Observed vs. Predicted D

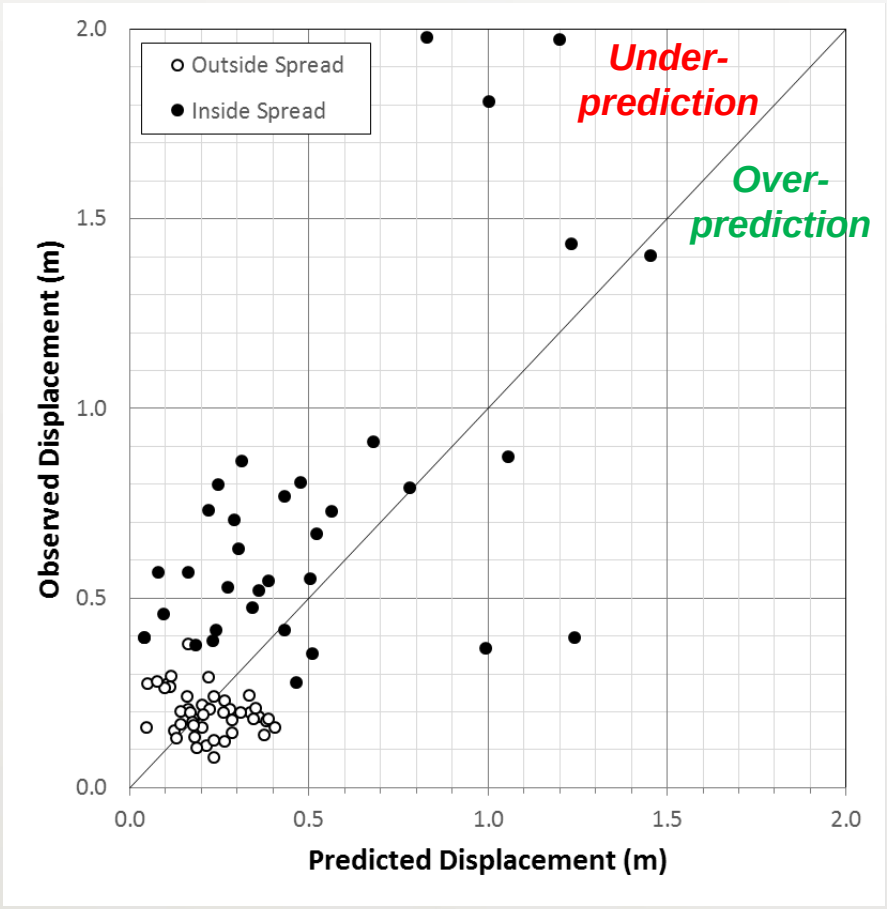


Residual vs. L/H

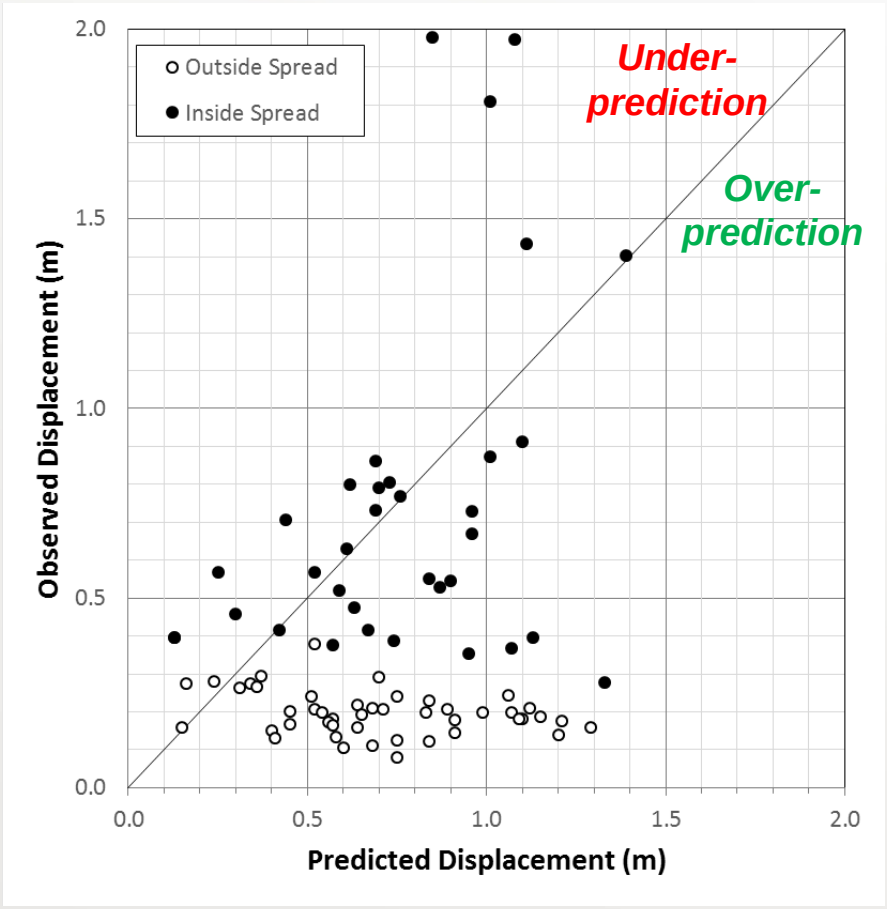


Zhang et al. (2004)

Observed vs. Predicted D

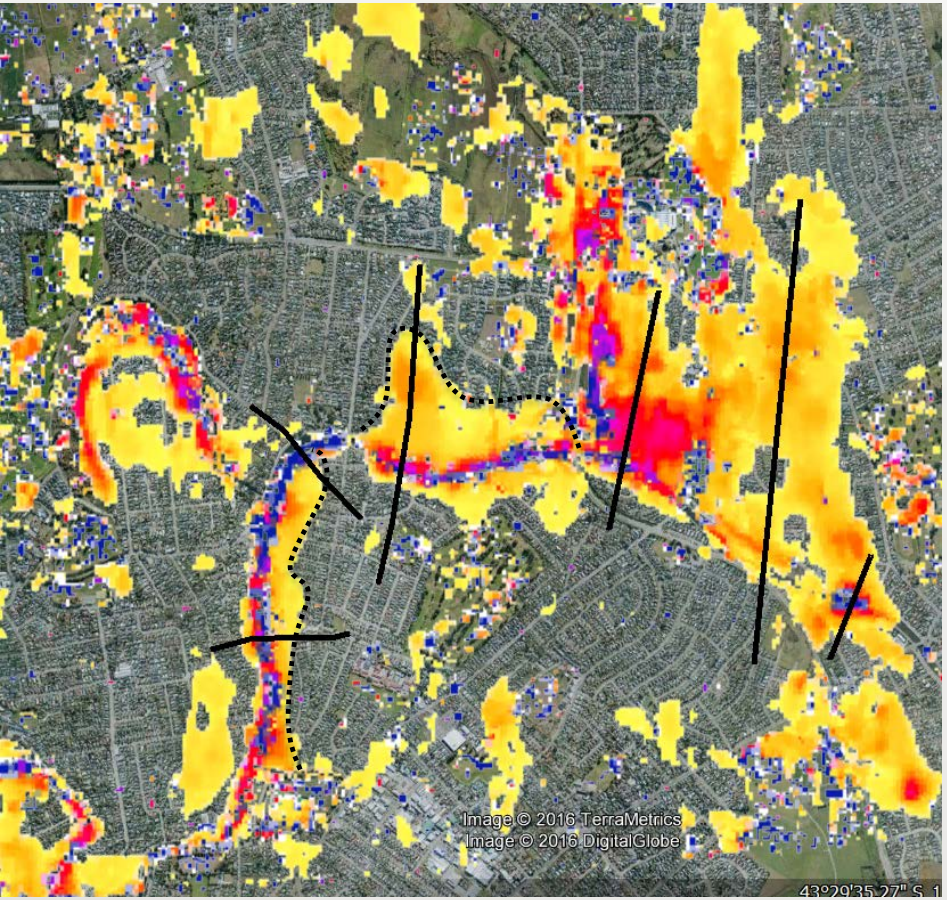


Observed vs. Predicted LDI

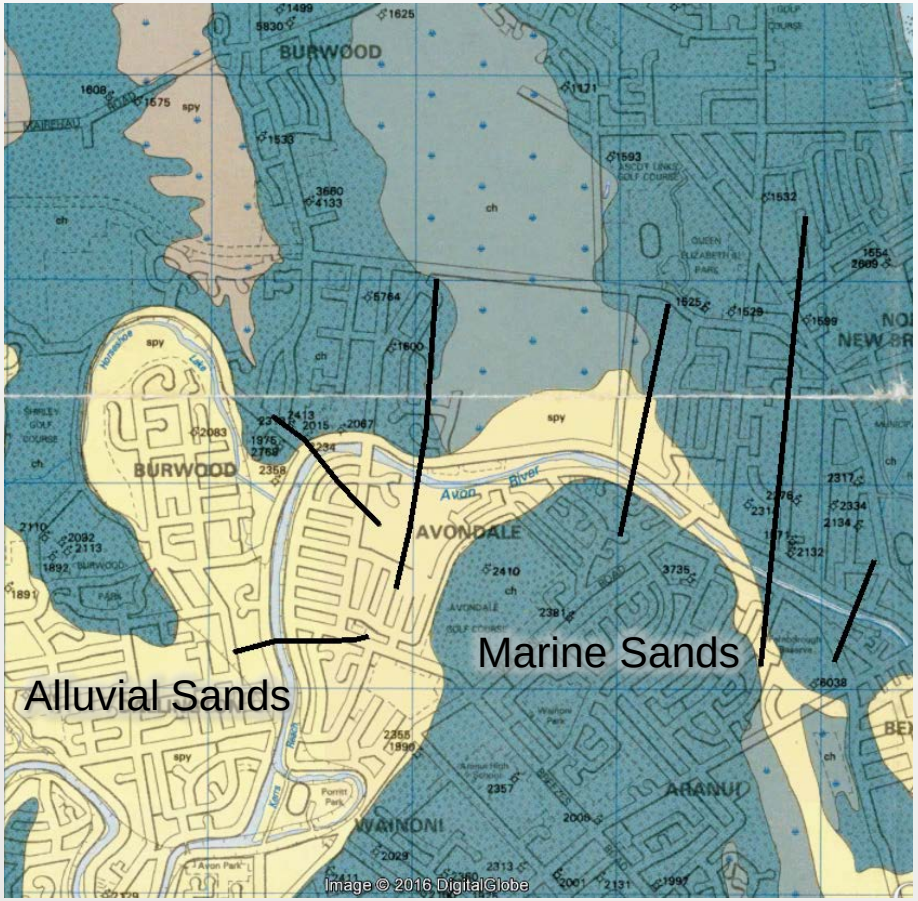


Influence of Geology/Geomorphology

Displacements



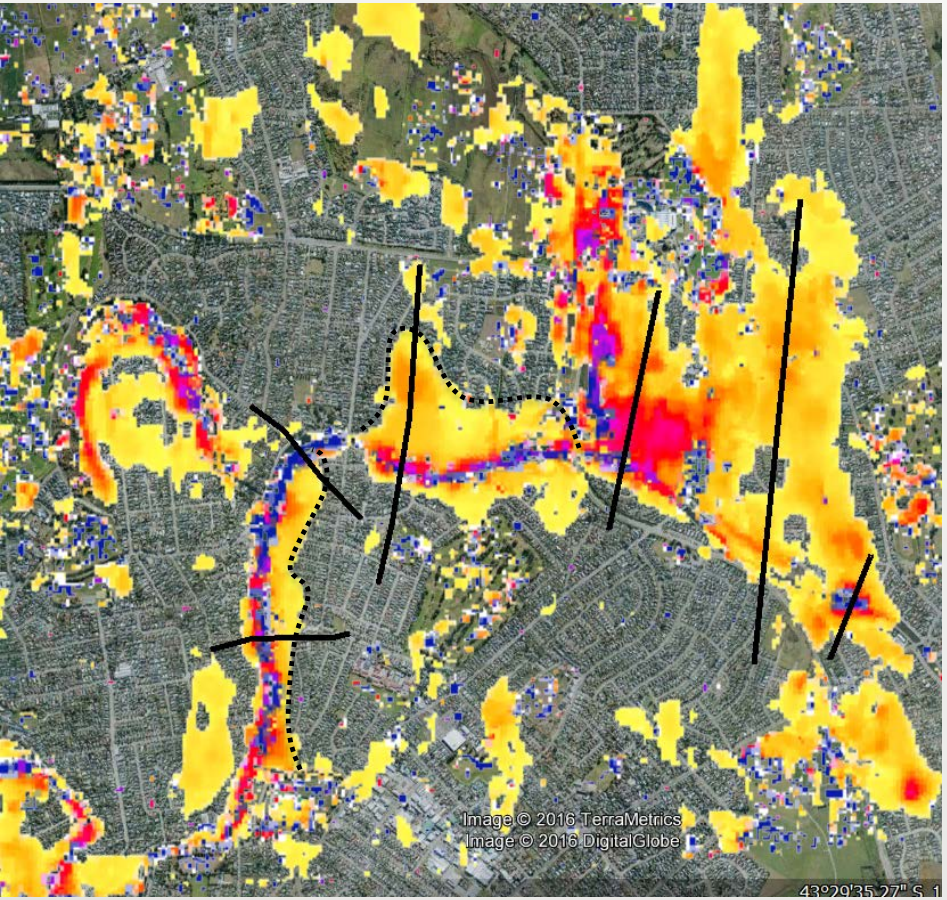
Geology



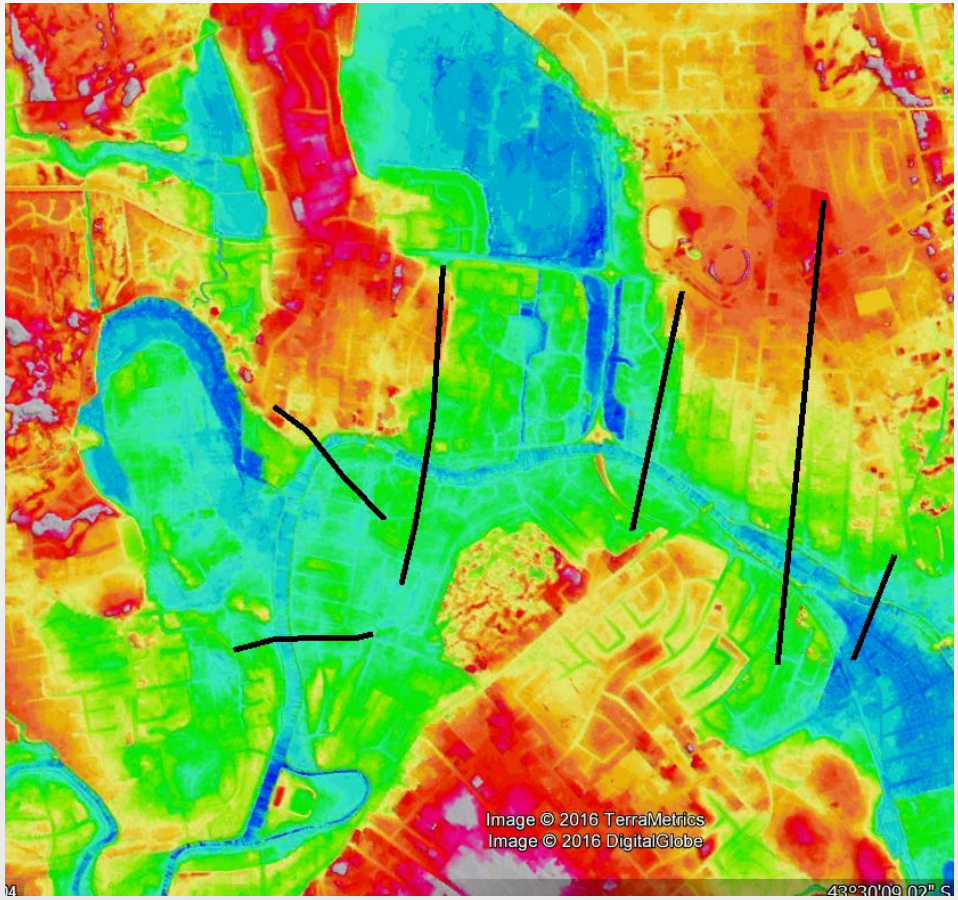
Brown and Weeber (1992) *GNS*

Influence of Geology/Geomorphology

Displacements



Elevation



Summary

- Data, data, data
  - More published datasets with all ancillary data
  - Use of remote sensing in the future
  - Physical models to fill gaps?
- Predictive models
  - Retire empirical models based on M, R
  - Refine semi-empirical models
  - Consider dependence of displacements, incorporate geology/geomorphology
  - Move towards advanced analyses (finite element)