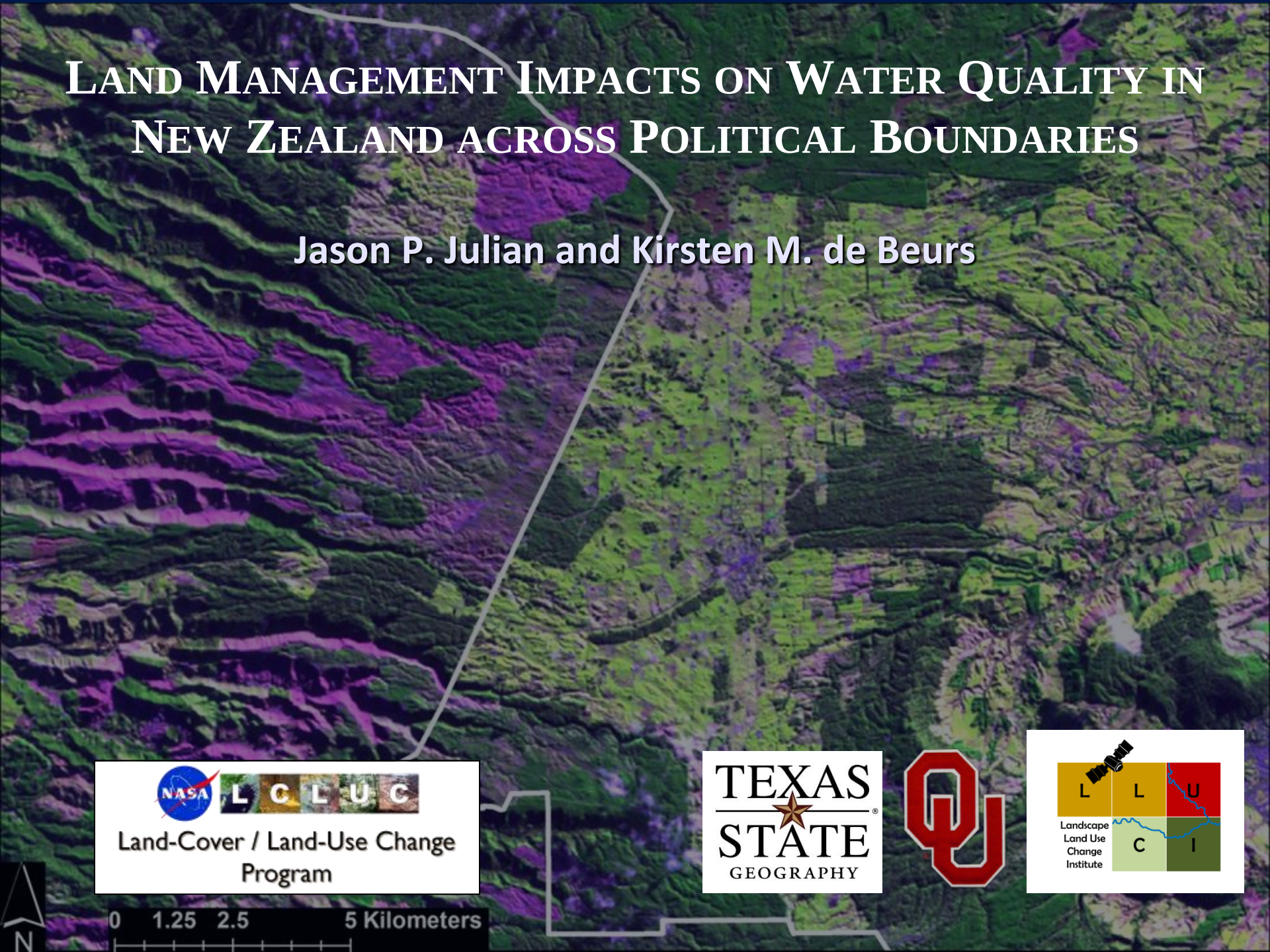
Land Management Impacts on Water Quality in New Zealand across Political Boundaries

Jason P. Julian and Kirsten M. de Beurs



Research Team

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Watershed Science, Env. Geography

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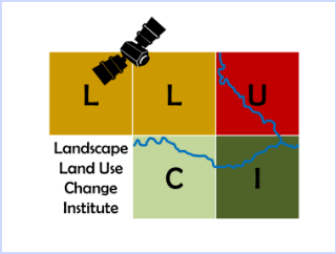
Remote Sensing, Land Use Change



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New Zealand collaborators

Landcare Research
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NIWA
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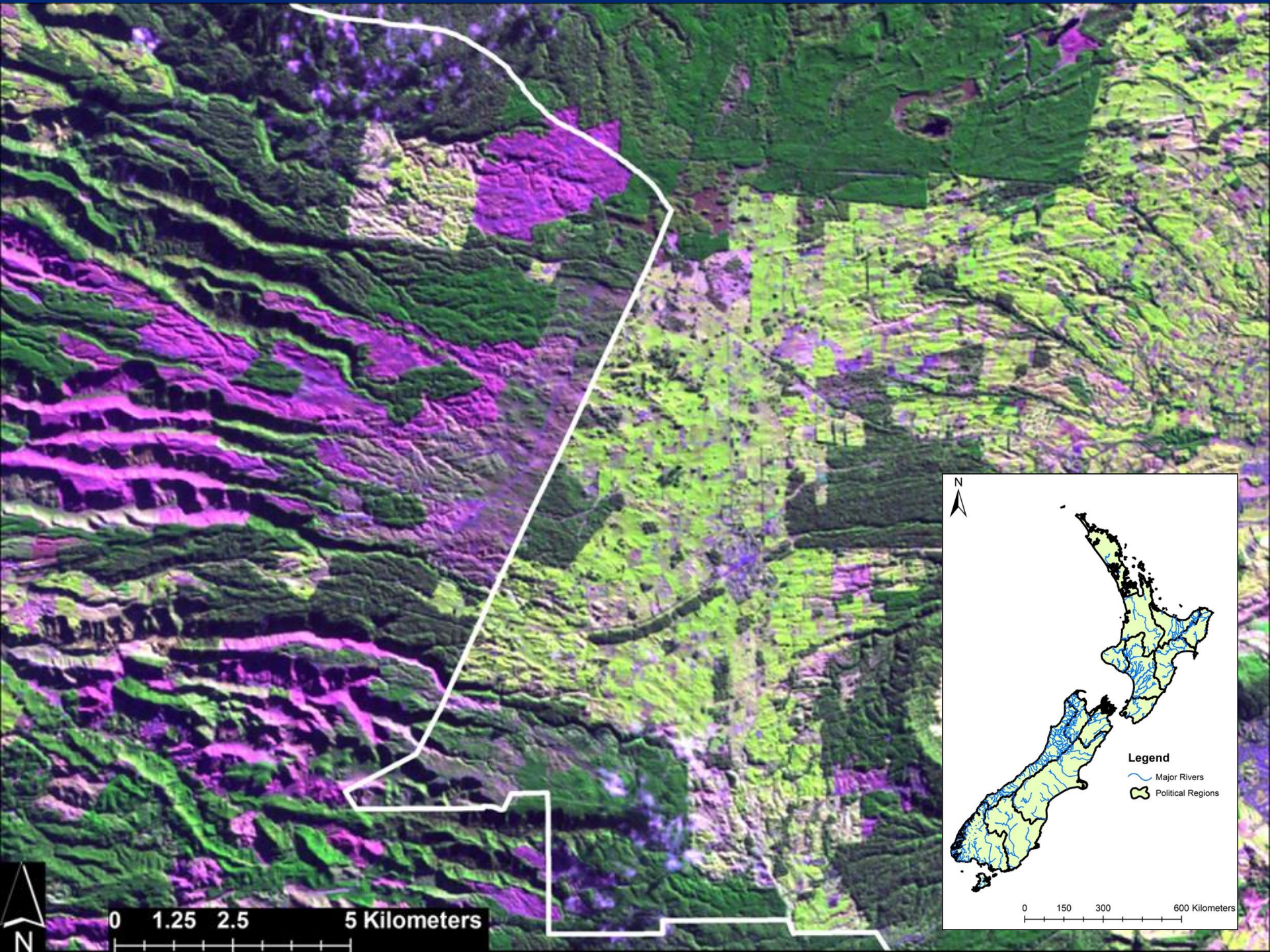
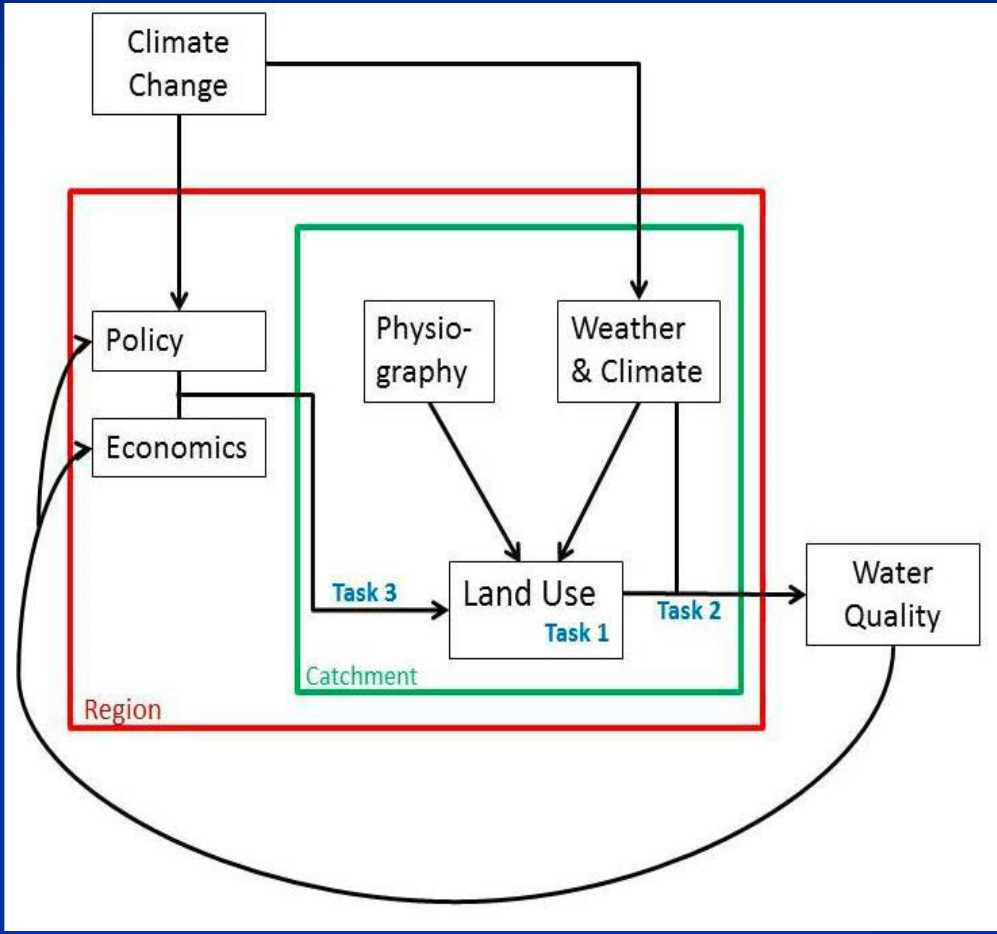
Regional Councils
Waikato: Beat Huser & Reece Hill
Canterbury: Raymond Ford
Tasman: Trevor James & Mary Baker
Horizons: Jon Roygard & Maree Clark


N
0 1.25 2.5 5 Kilometers
N
Legend
Major Rivers
Political Regions
0 150 300 600 Kilometers

How does land management impact water quality across broad and multiple scales?

First ever comparison of 8-day land cover change (at 30 m) with long-term water quality datasets (>25 years) at multiple resolutions

Project Workflow



Task 1: Detect and map land cover/use changes at fine resolution (30-m, 8-day)

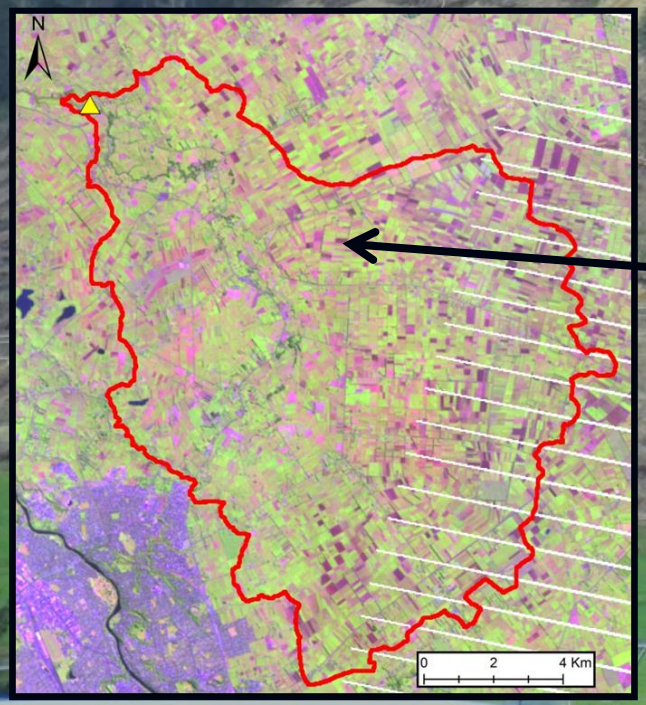
Task 2a: Determine landscape-river connectivity

Task 2b: Compare weekly land use to monthly water quality

Task 3: Compare land use time series to socioeconomic /policy timelines to assess how land management affects water quality

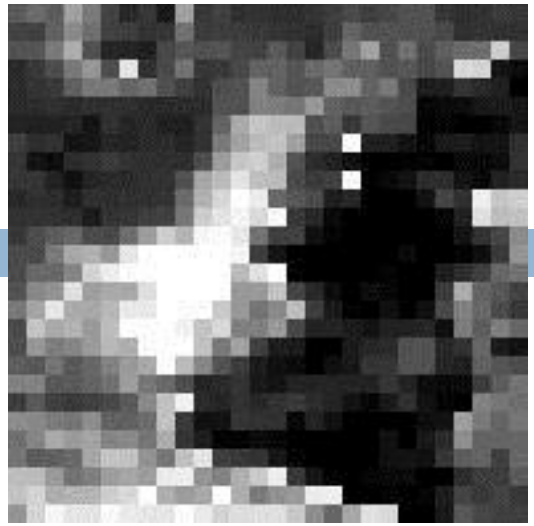
Task 1

1. Detect date, location, and extent of forest & grassland disturbance events



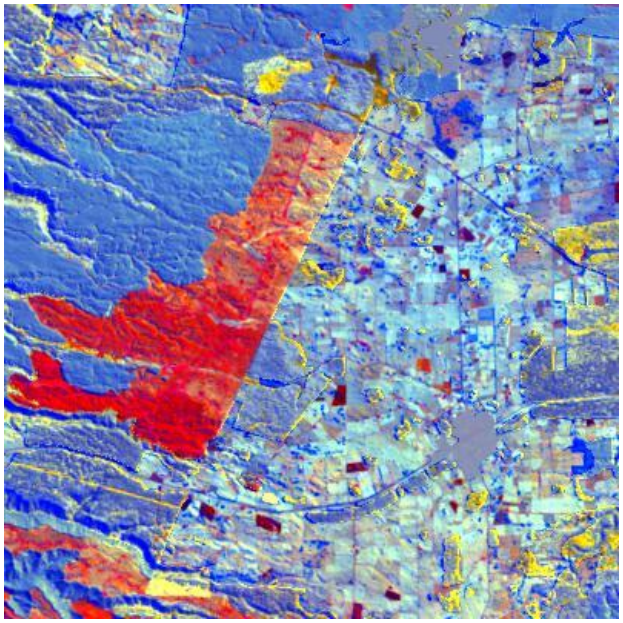
Land Disturbance

- MODIS-NBAR: 500 meter, 8-day resolution
- Landsat: 30 meter, multiple/year
- Compare Brightness, Greenness, & Wetness of images

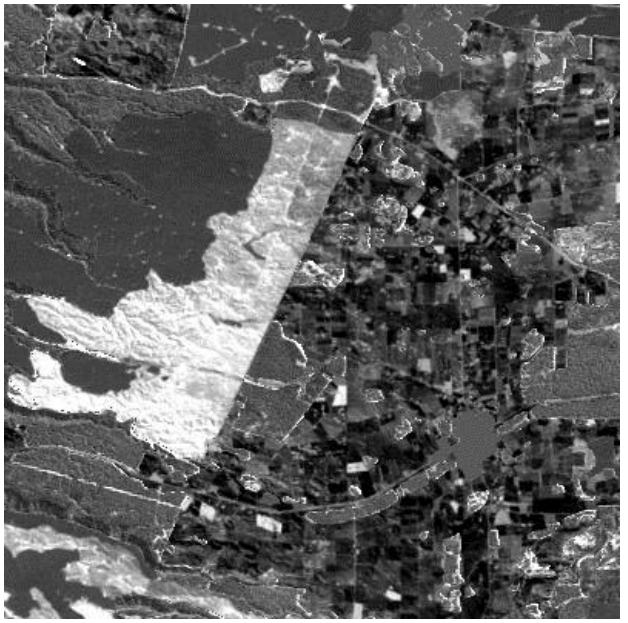


MODIS Disturbance

True Color Landsat image



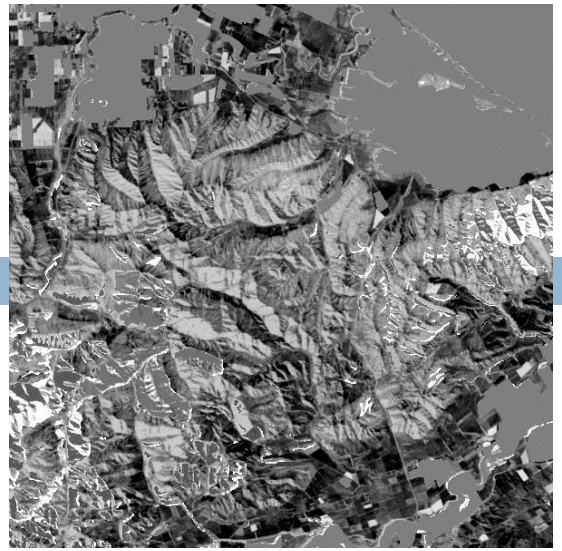
Landsat Tasseled Cap



Landsat Disturbance

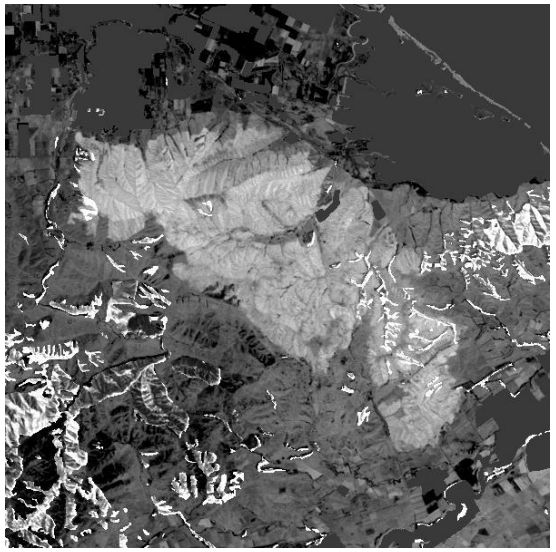
Major forest harvest on the border between Waikato and Bay of Plenty in 2000

Data Fusion

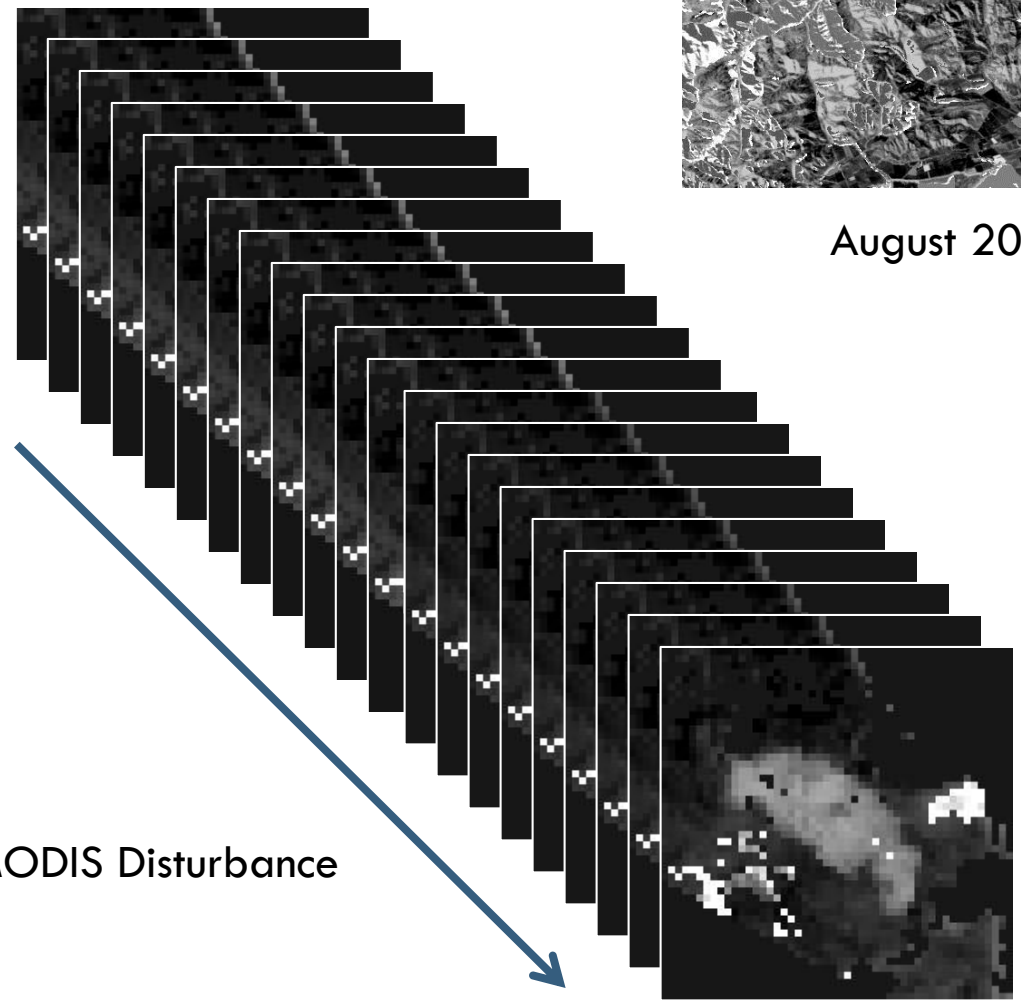


August 2000

Landsat Disturbance



Feb 2001

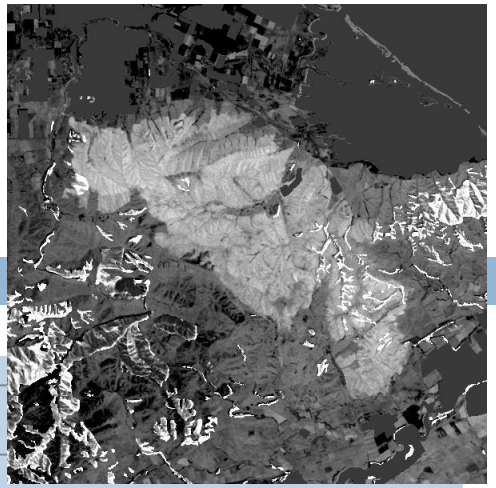


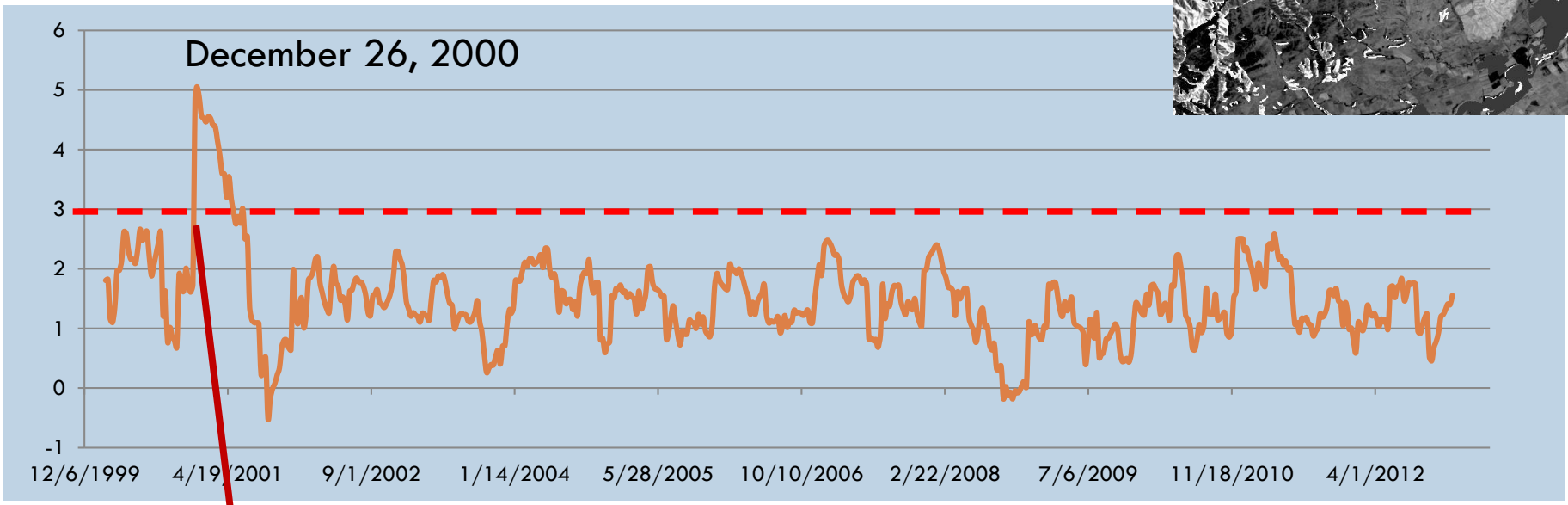
MODIS Disturbance

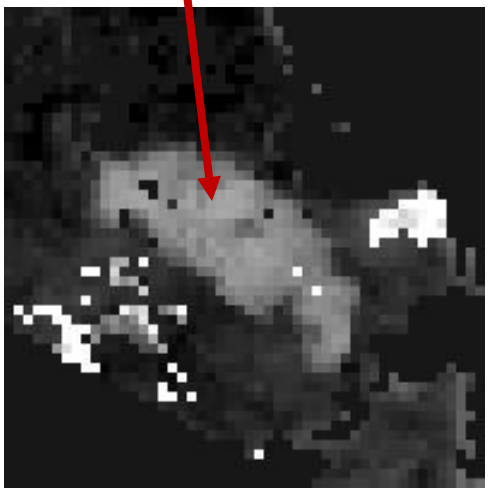
Disturbance occurred some time between August 2000 and February 2001.

But when exactly?

Disturbance and Recovery







- Disturbance time series for one MODIS pixel
- Recovery trajectory and disturbance pattern
- Fused data allows us to assess location and extent

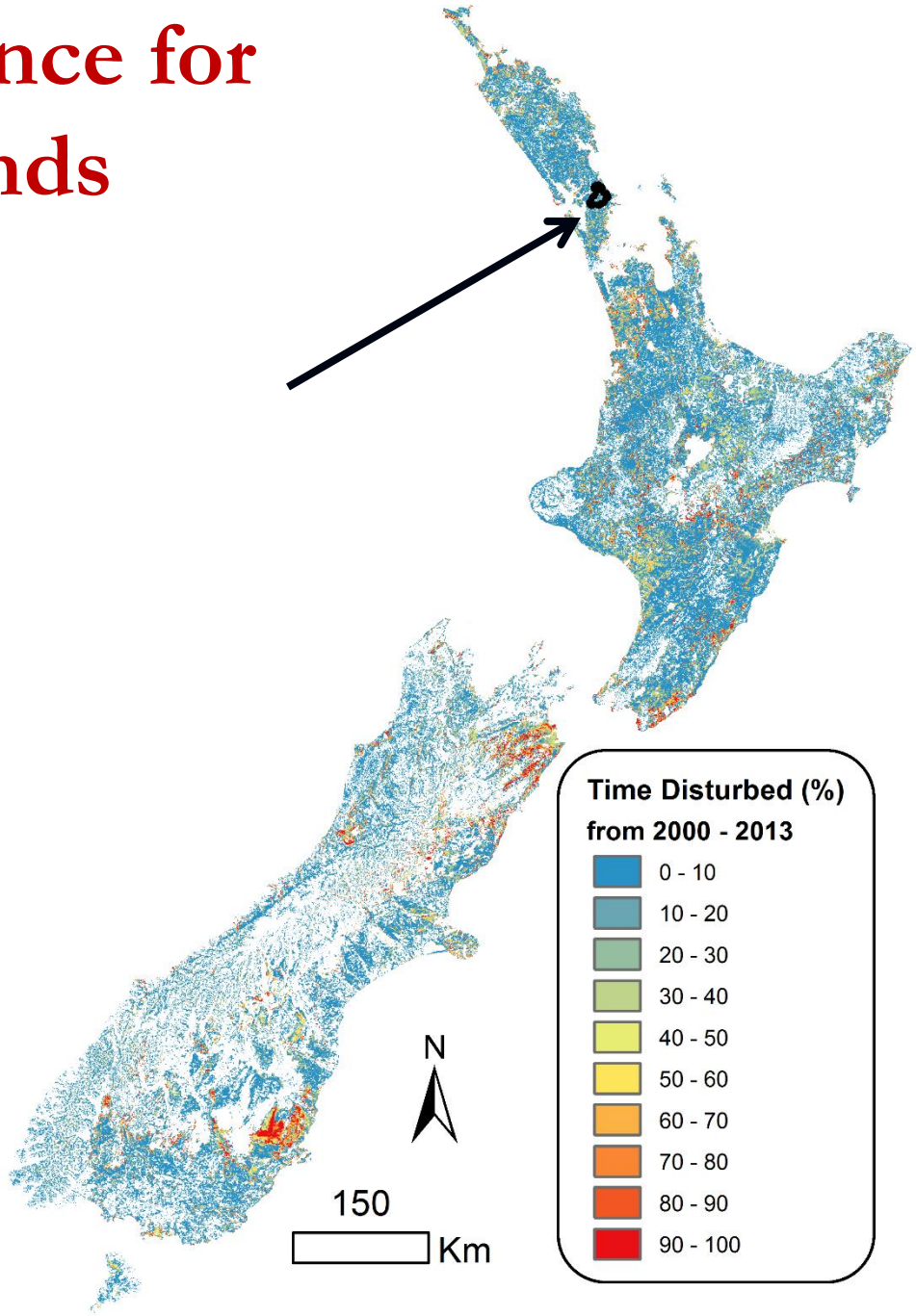
Nationwide disturbance for forests & grasslands

Feb 2000 – Dec 2013

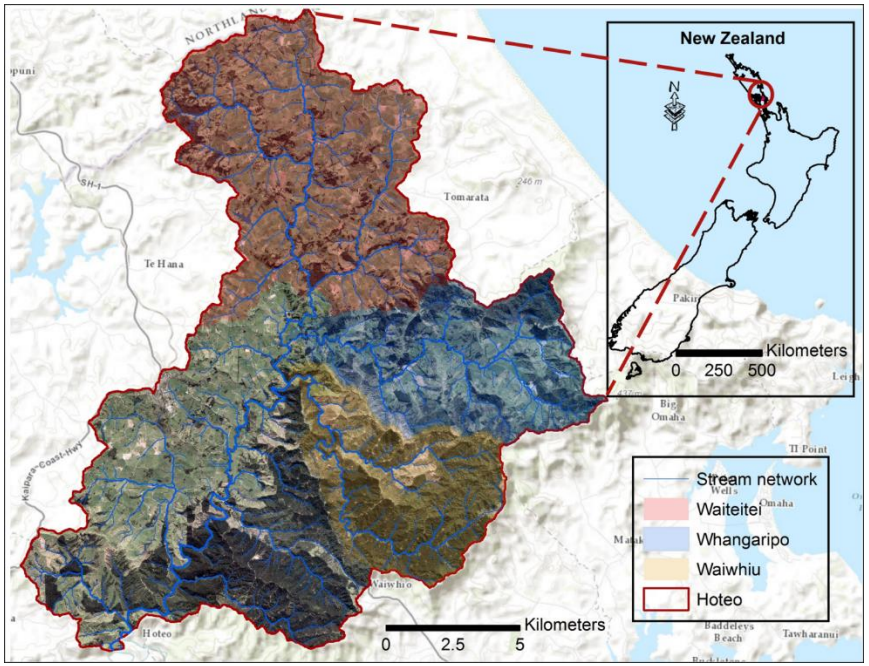
Completed
MODIS: 500-m, 8-day

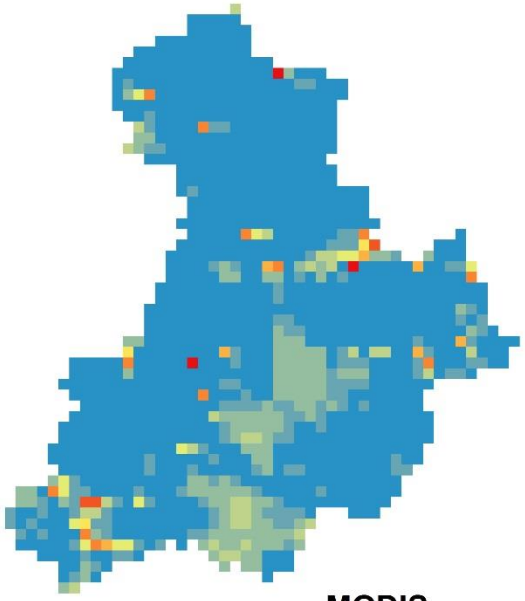
Landsat: 30-m, multiple/year

Almost complete
Fused data: 30-m, 8-day



Hoteo Catchment

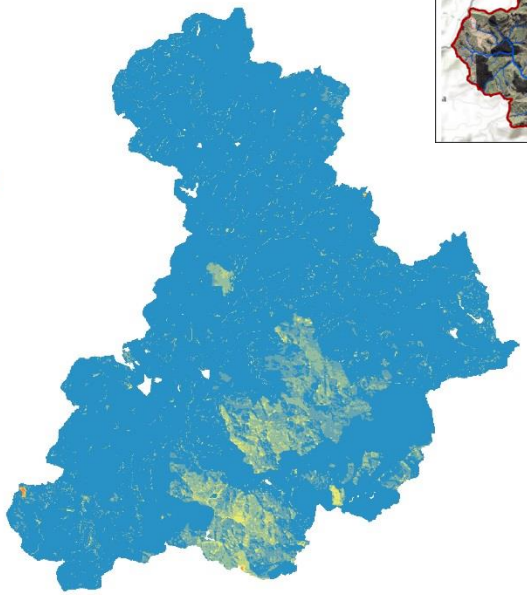




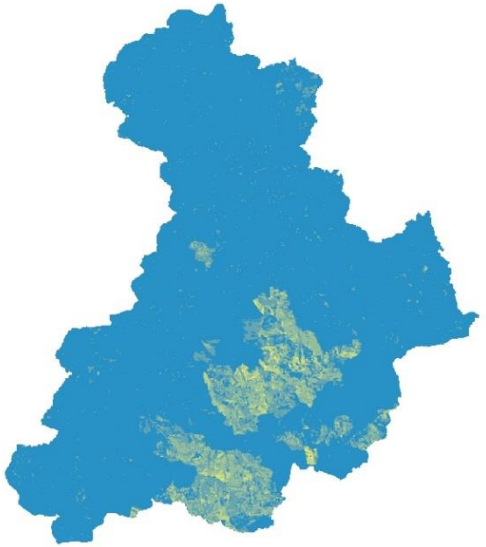
MODIS

% of time disturbed

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100



Landsat

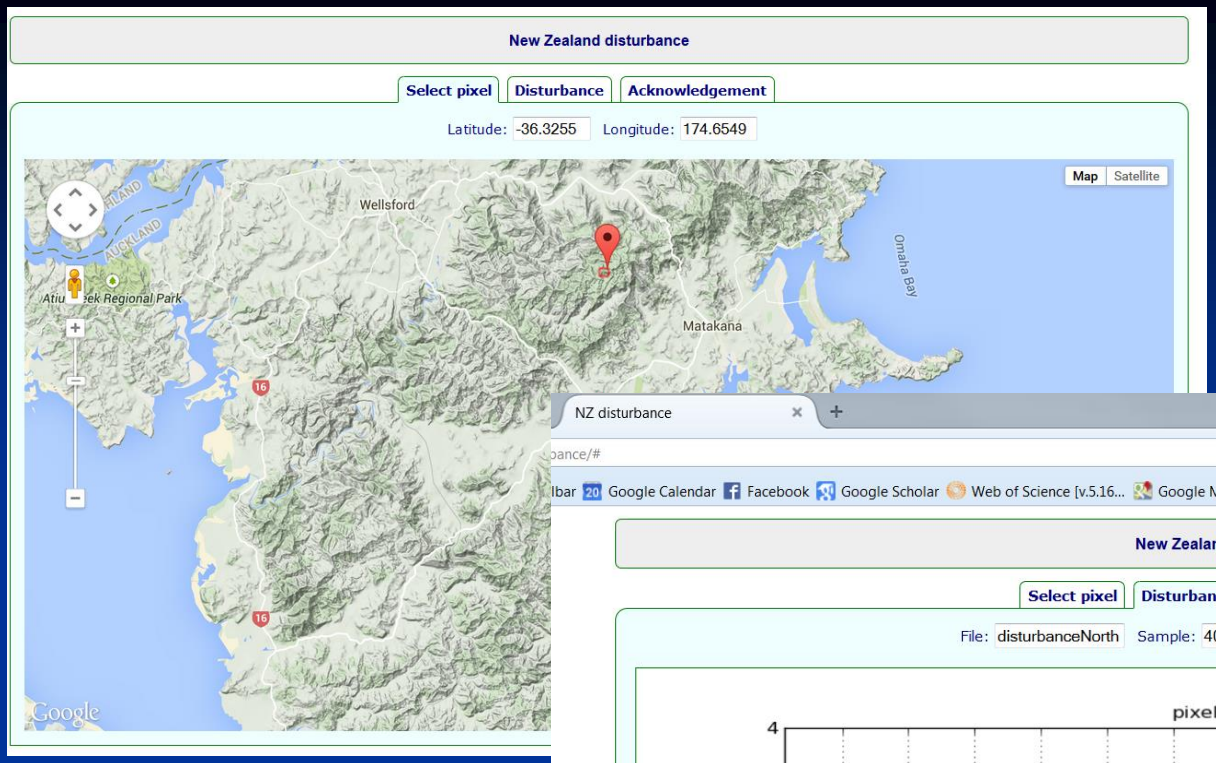


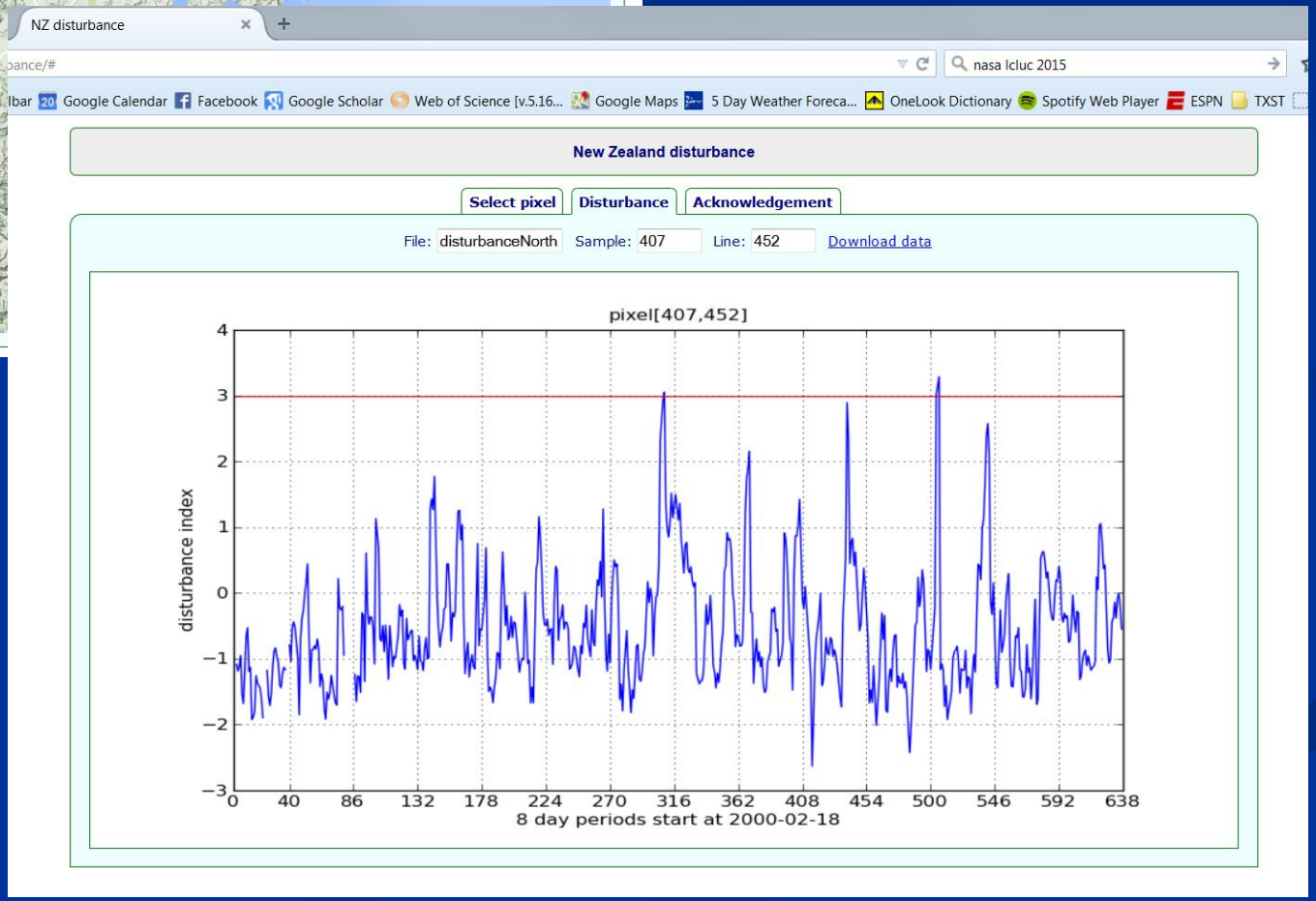
Fusion

N
W E
S

Kilometers
0 5 10 20

MODIS disturbance dataset available on our website

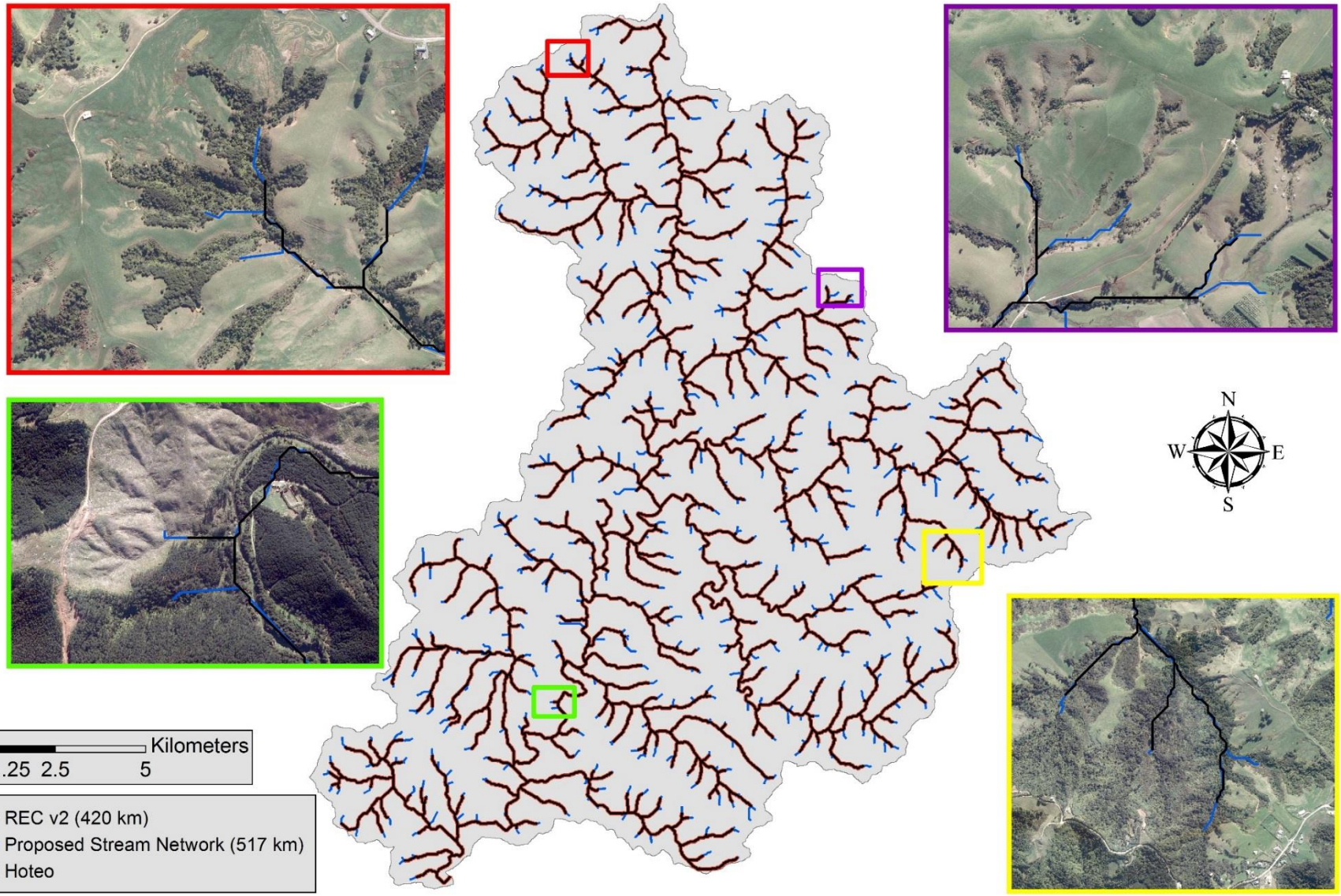




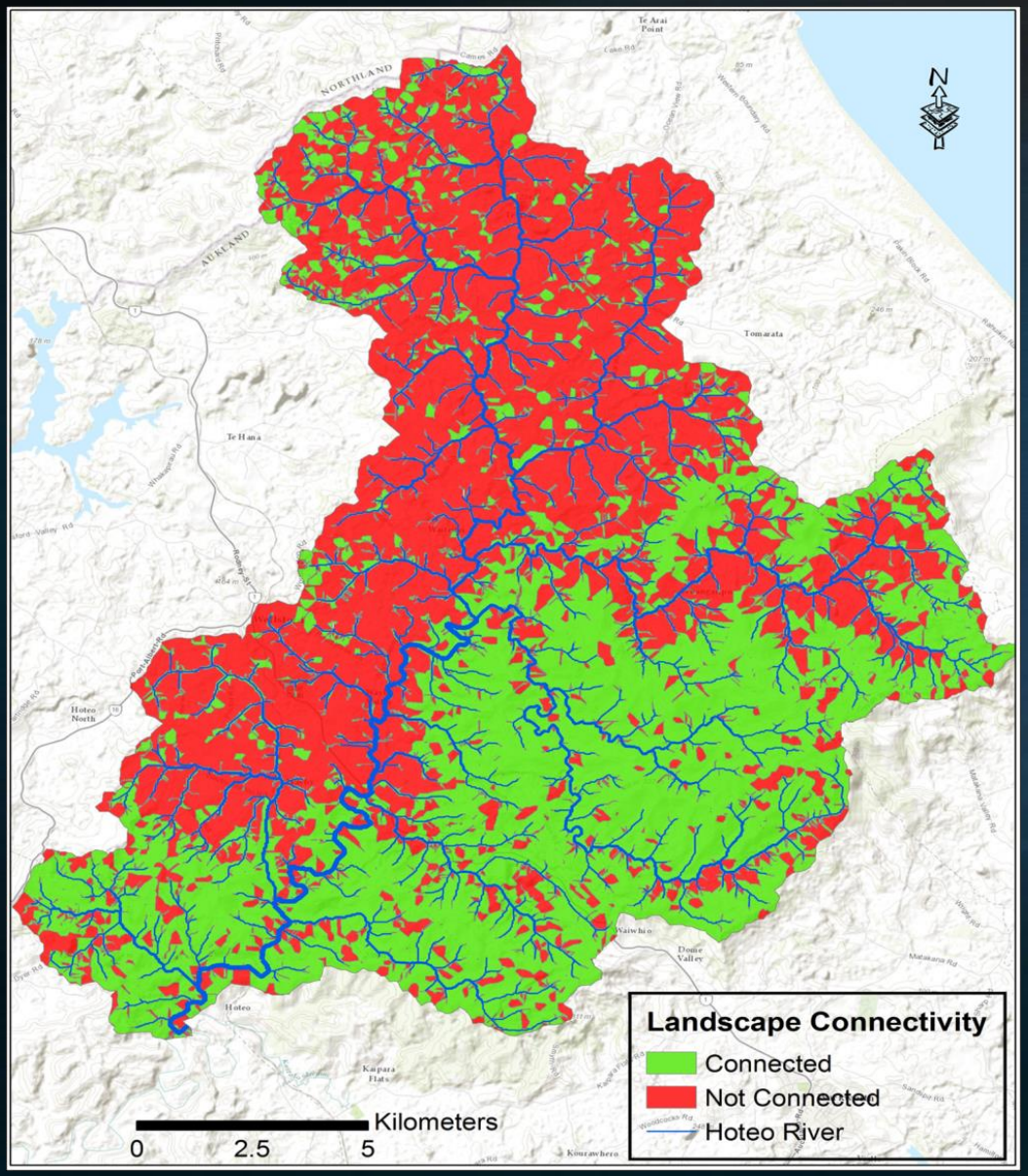
Landscape Land Use Change Institute

http://tethys.dges.ou.edu/NZ_disturbance

Task 2a: Develop a more accurate channel network



Landscape connectivity map for Hoteo Catchment

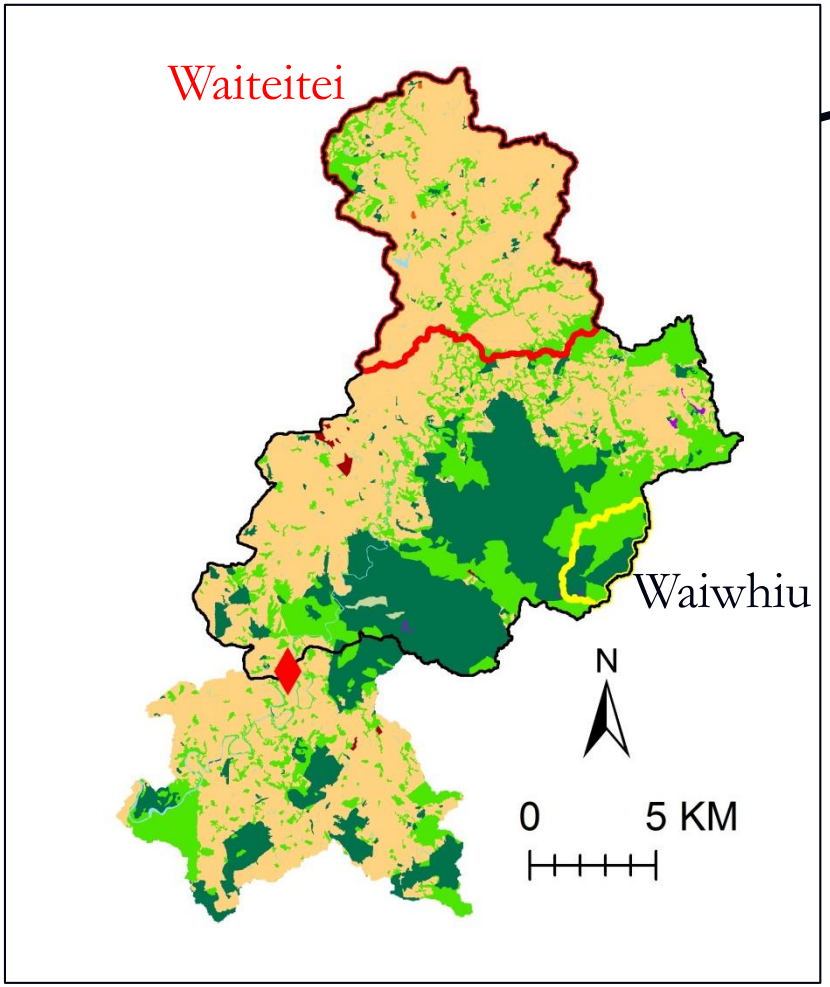


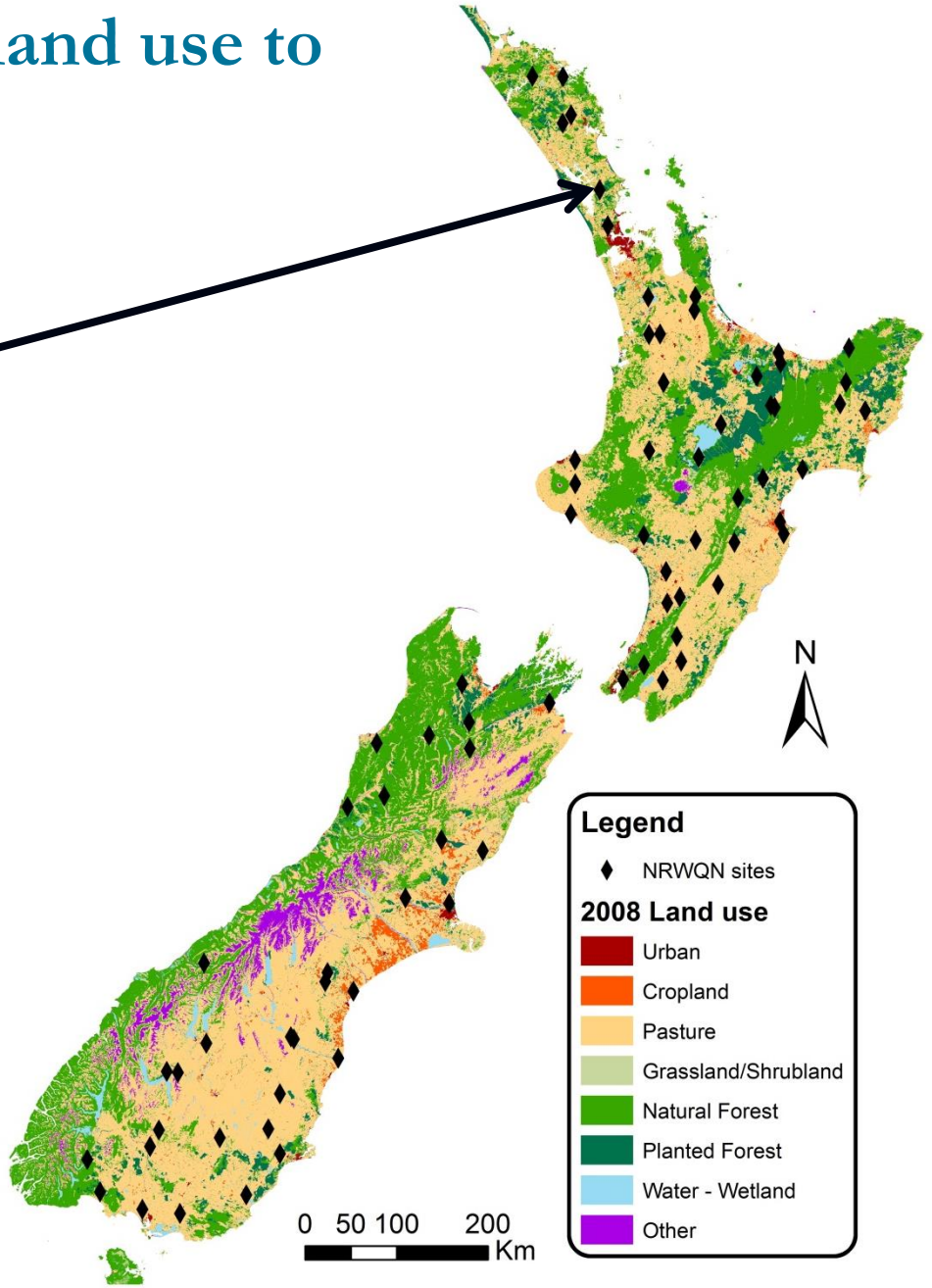
- Connected as long as slope > 5° for downward flow direction.
- If slope < 5° for at least two pixels, then disconnected.
- If next pixel is river or floodplain, then connected regardless of slope.

Use the connected areas as a mask on disturbed areas to define potential sediment runoff sources.

Steep slopes tend to be covered by plantation forest.

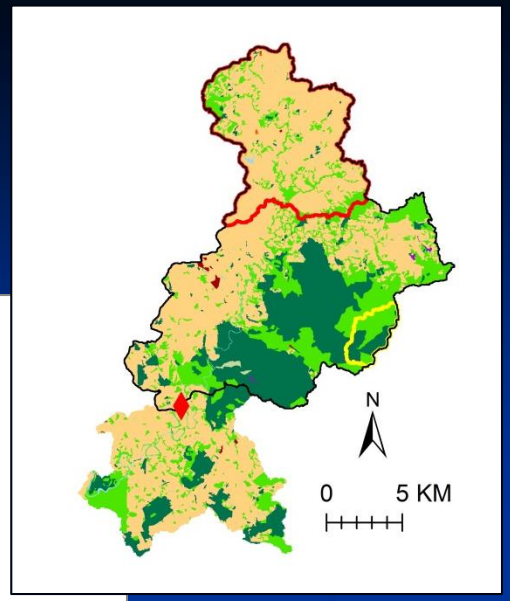
Task 2b: Compare weekly land use to monthly water quality

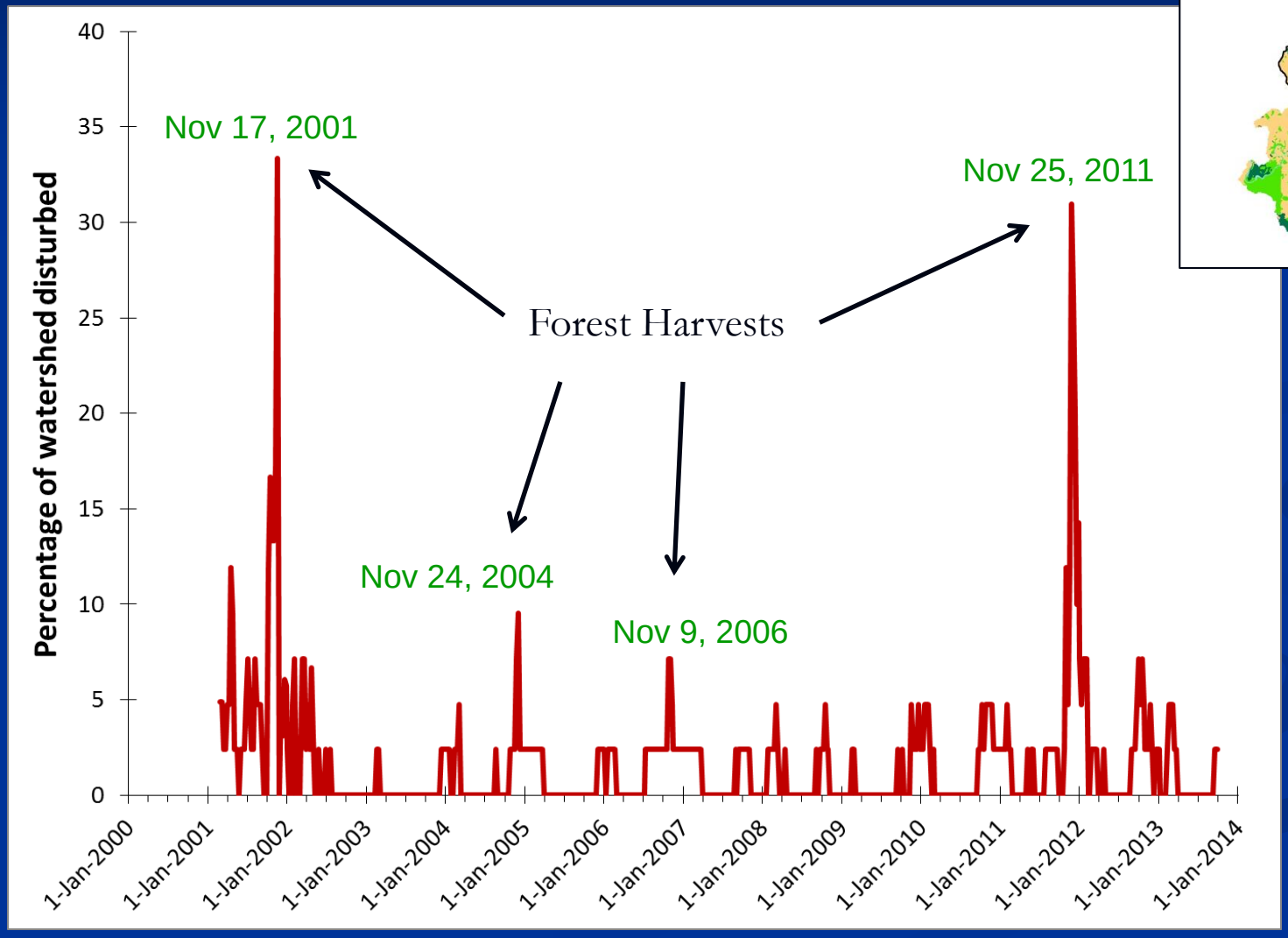




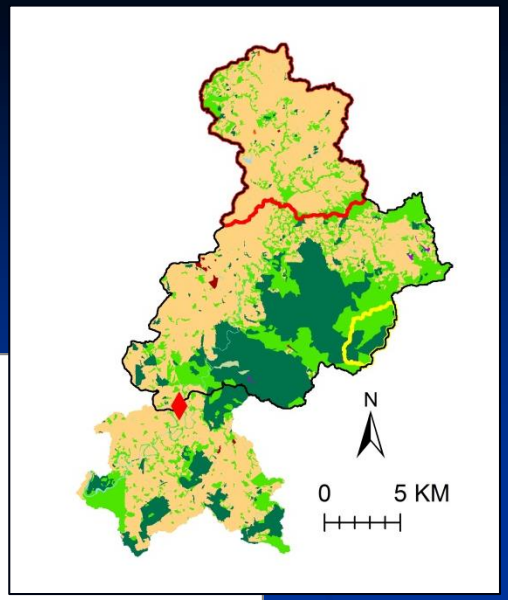
Hoteo Catchment, New Zealand

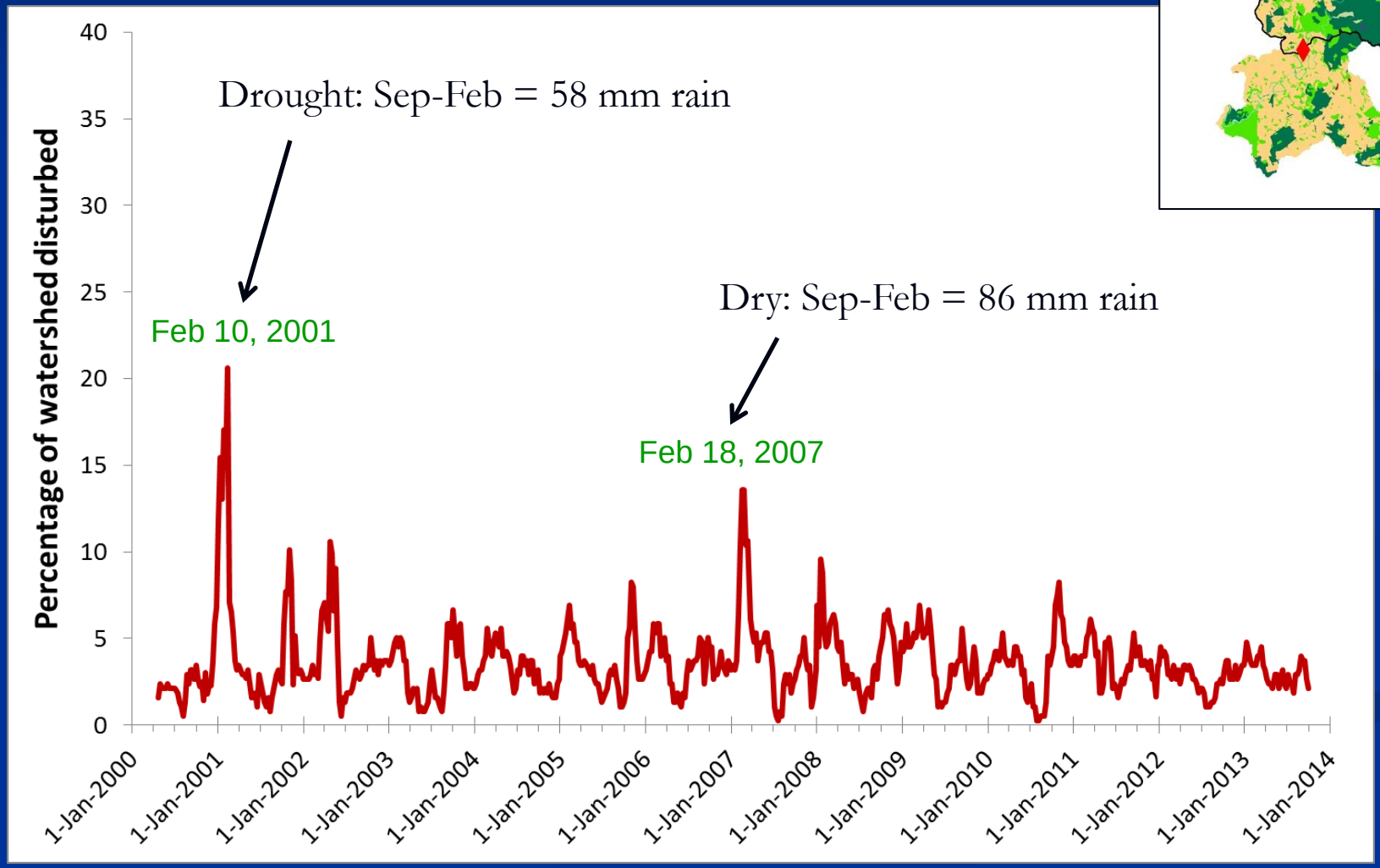
Waiwhiu (Plantation Forest catchment)

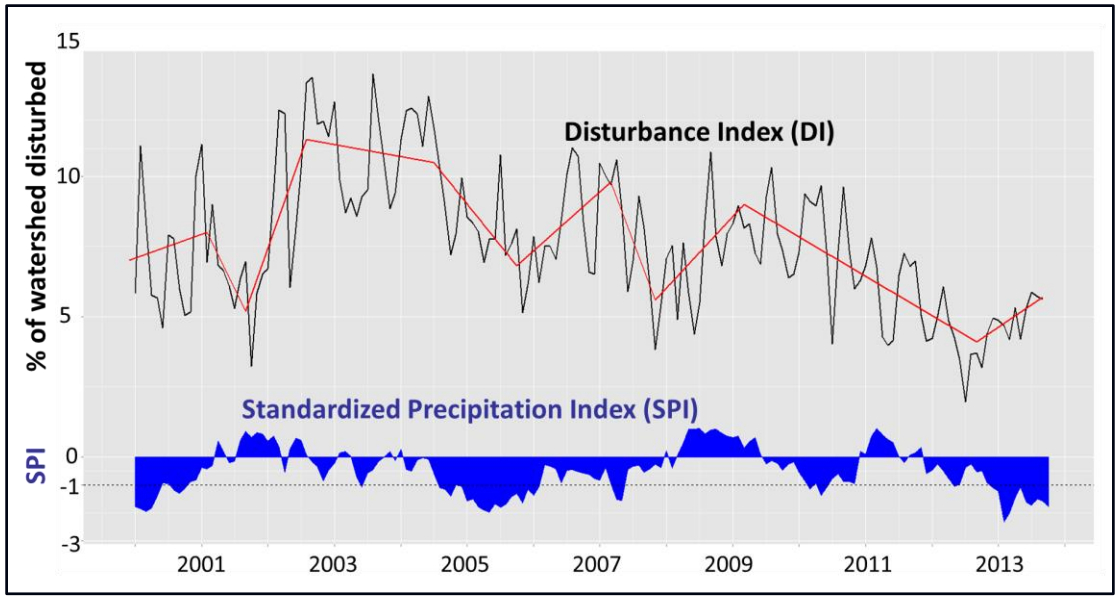


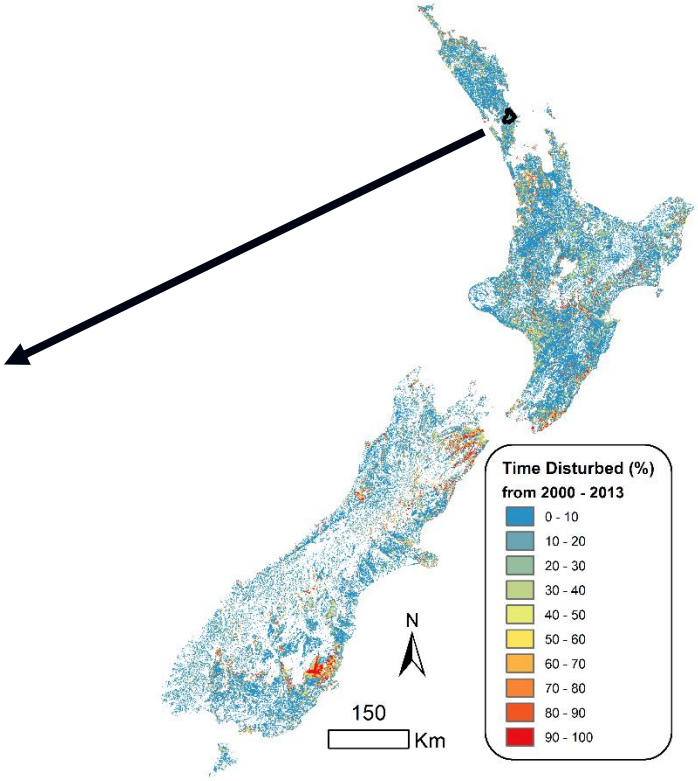


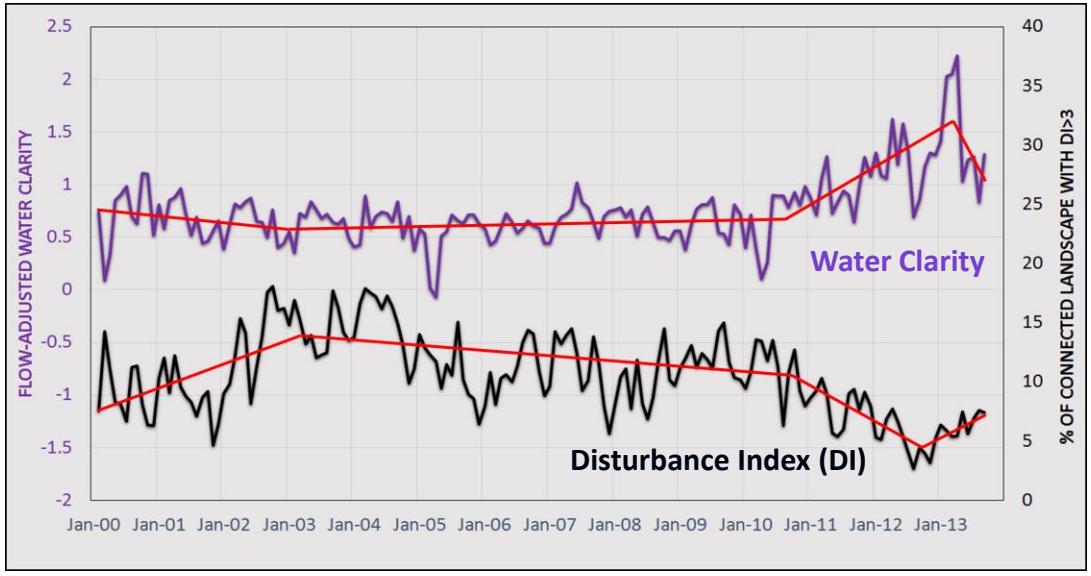
Waiteitei (Pasture catchment)

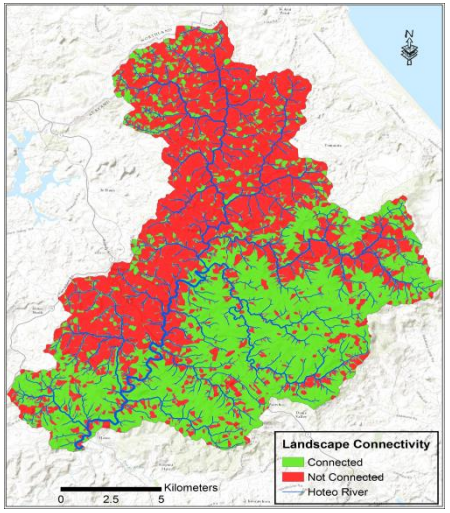





% of watershed disturbed
15
10
5
Disturbance Index (DI)
Standardized Precipitation Index (SPI)
SPI
0
-1
-3
2001
2003
2005
2007
2009
2011
2013


Time Disturbed (%)
from 2000 - 2013
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
N
150
Km


FLOW-ADJUSTED WATER CLARITY
% OF CONNECTED LANDSCAPE WITH DI>3
Water Clarity
Disturbance Index (DI)
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13


Landscape Connectivity
Connected
Not Connected
Hoteo River
Kilometers
0
2.5
5

Task 3: Compare land use time series to socioeconomic/policy timelines to assess how land management affects water quality

National Datasets

National Policy Statements

Agricultural goods pricing data (Forestry, Dairy, Beef, Lamb)

- annual data 1992-2012

Land use intensity and production data (2002, 2007, 2012)

Farmer perception & use surveys

Regional Datasets (for Canterbury, Waikato, Horizons, Auckland)

Land Use/Management Plans

Water Quality Plans

What's left?

- Data fusion for the entire nation
- LCLUC & Water quality comparisons for other 76 National Network sites and ~25 State of the Environment sites
- Rigorous time-series analyses of LCLUC, water quality, and socioeconomic data
- Forecast effects of land management policy changes (e.g. doubled productivity by 2025) on water quality

QUESTIONS?

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TEXAS STATE GEOGRAPHY