Visualizing Decadal Landscape Changes Using NDVI Time Series of Different Resolution with the CAT Transform

Greg McDermid[1], Jennifer N. Hird[1] Guillermo Castilla[2,1], Rasim Latifovic[3], Darren Pouliot[3], Ron Hall[2]

[1]University of Calgary, Geography Department
[2]Natural Resources Canada, Canadian Forest Service
[3]Natural Resources Canada, Canadian Center for Earth Observation

July 24th
MultiTemp 2015| Annecy, France

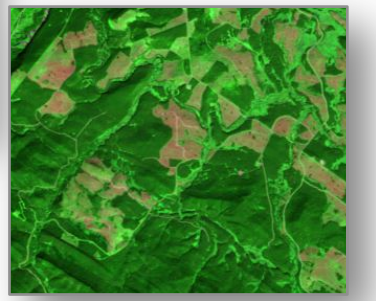
The Bi-Temporal Approach

Regions subject to intense resource development such as Alberta can benefit from EO monitoring

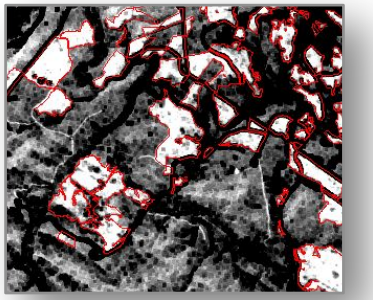
Typically, EO-based change analysis has been bi-temporal

'Before' Landsat (c. 2000)

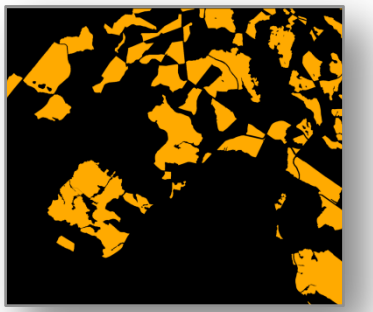
vs.



'After' Landsat (c. 2010)



Difference Image



Change Areas

The Multi-Temporal Perspective

Increasingly, multi-temporal approaches are replacing bi-temporal methods

We asked:

- Can the change information embedded in the time series be compressed into a single image for visualization purposes?
- Could this summary image be used for quantitative analysis?
- Would the same method work for time series from different sensors and resolutions?

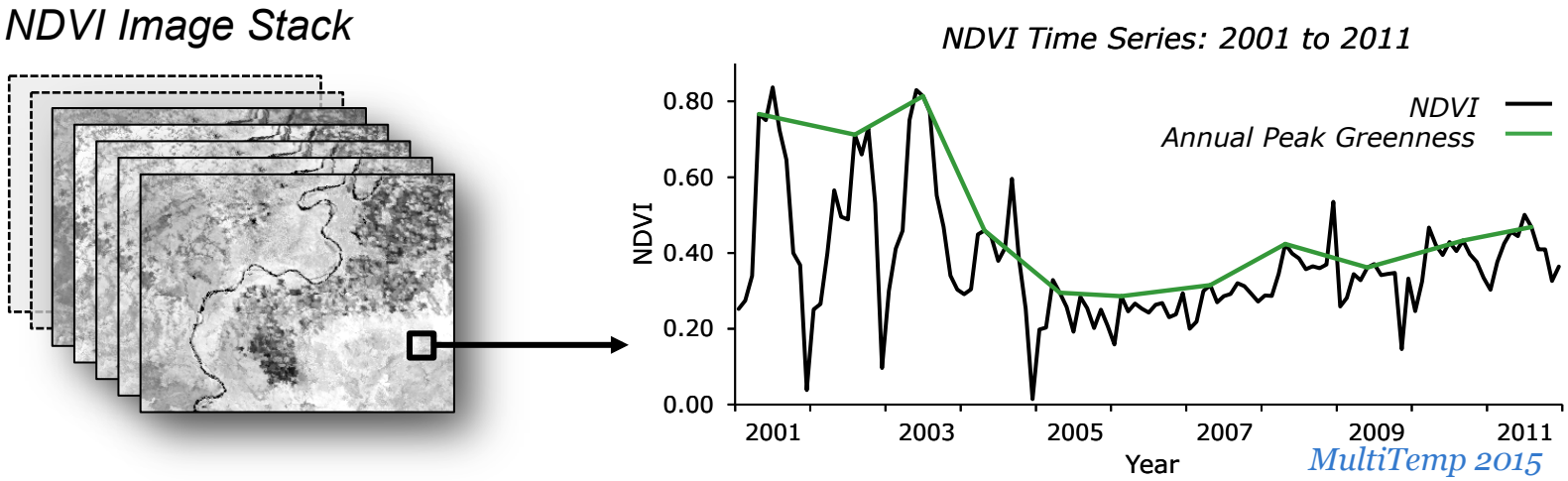
Material and Methods

MODIS 16-day 250m NDVI ('greenness') time series covering Alberta, 2001-2011

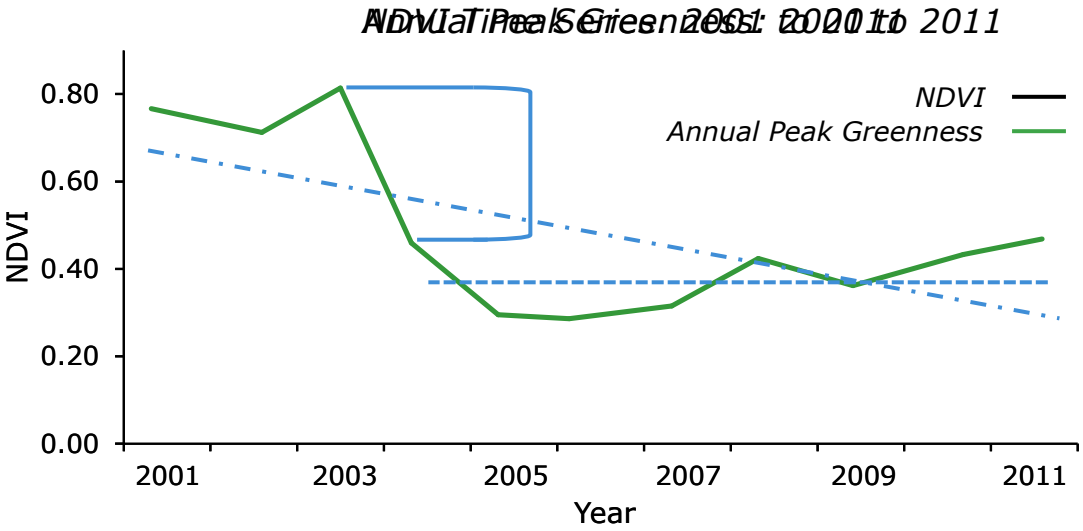
Landsat TM/ETM+ NDVI time series covering a 112.5 x 150 km in the Alberta oil sands, 2001-2011

Applied the CAT (Change, Aftereffect and Trend) Transform to both

Assessed visually, quantitative case study, compared MODIS/Landsat



The CAT Transform



Change: 0.355 [NDVI]

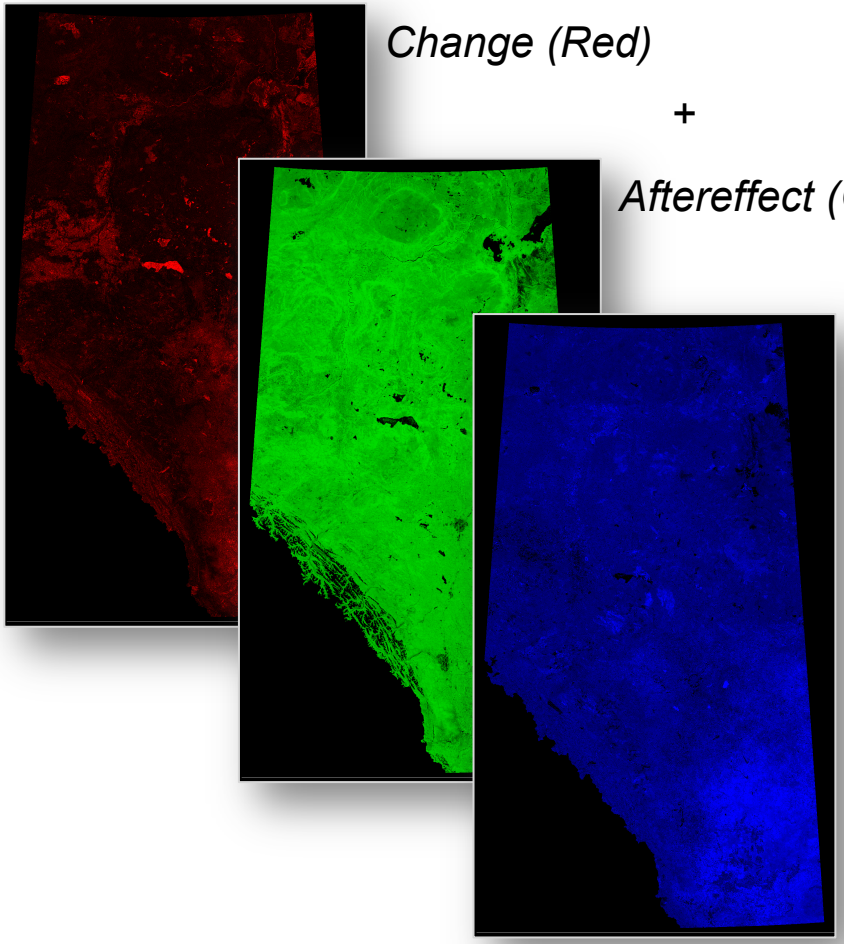
Aftereffect: 0.381 [NDVI]

Trend: -4% [slope]

CAT Transform applied to annual peak greenness time series yields three variables:

- Change: the largest inter-annual change in greenness during the period (whether positive or negative)
- Aftereffect: average greenness following the above change
- Trend: the overall direction and magnitude of long-term changes in greenness for the period

Results: Visualization



Change (Red)

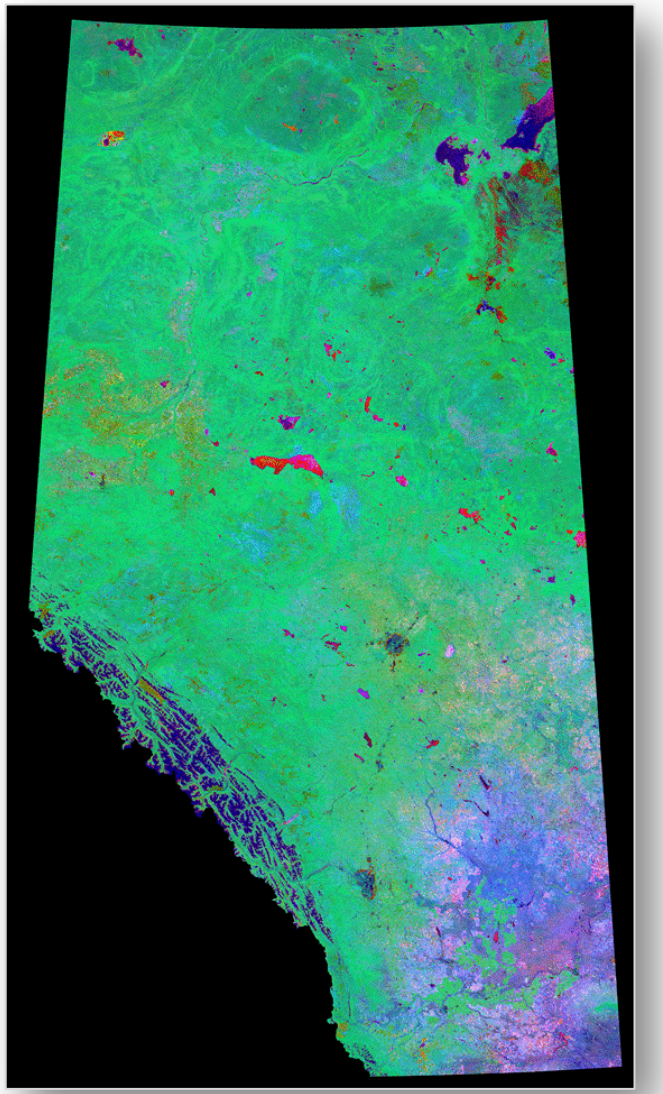
+

Aftereffect (Green)

+

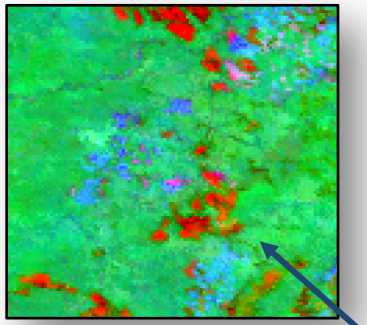
Trend (Blue)

=

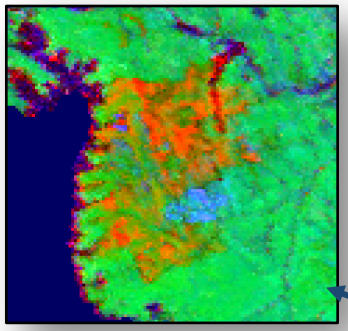


False-colour composite highlighting landscape change

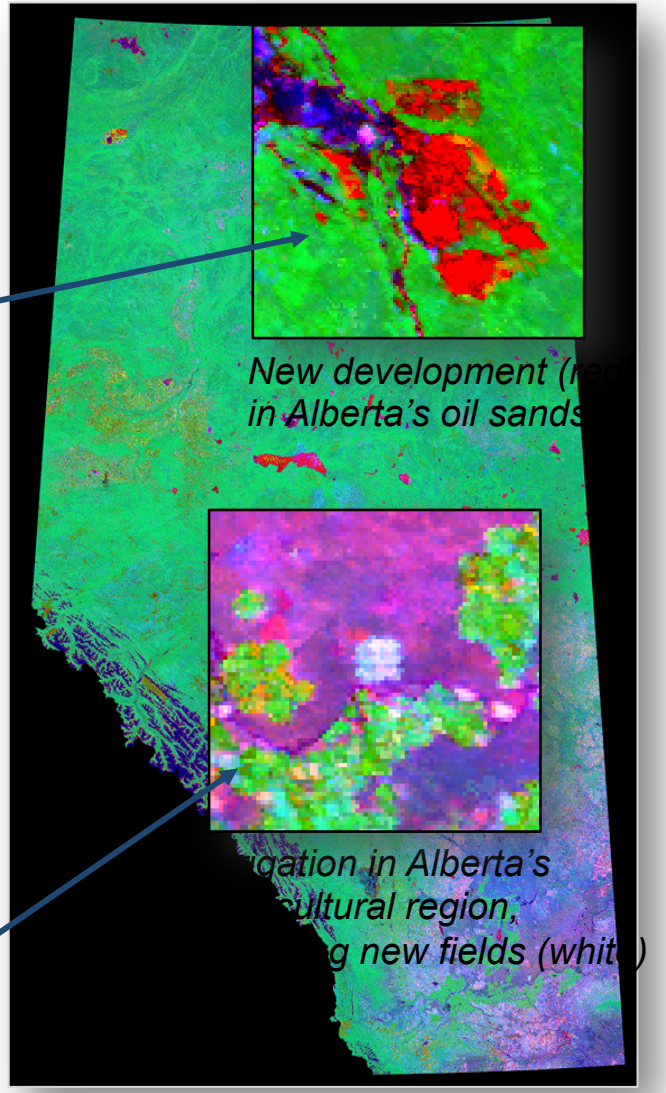
Results: Visualization



New (red) and recovering (blue) cutblocks (clearcuts) in Alberta's forested region



Wildfire (orange) in Alberta's Rocky Mountains



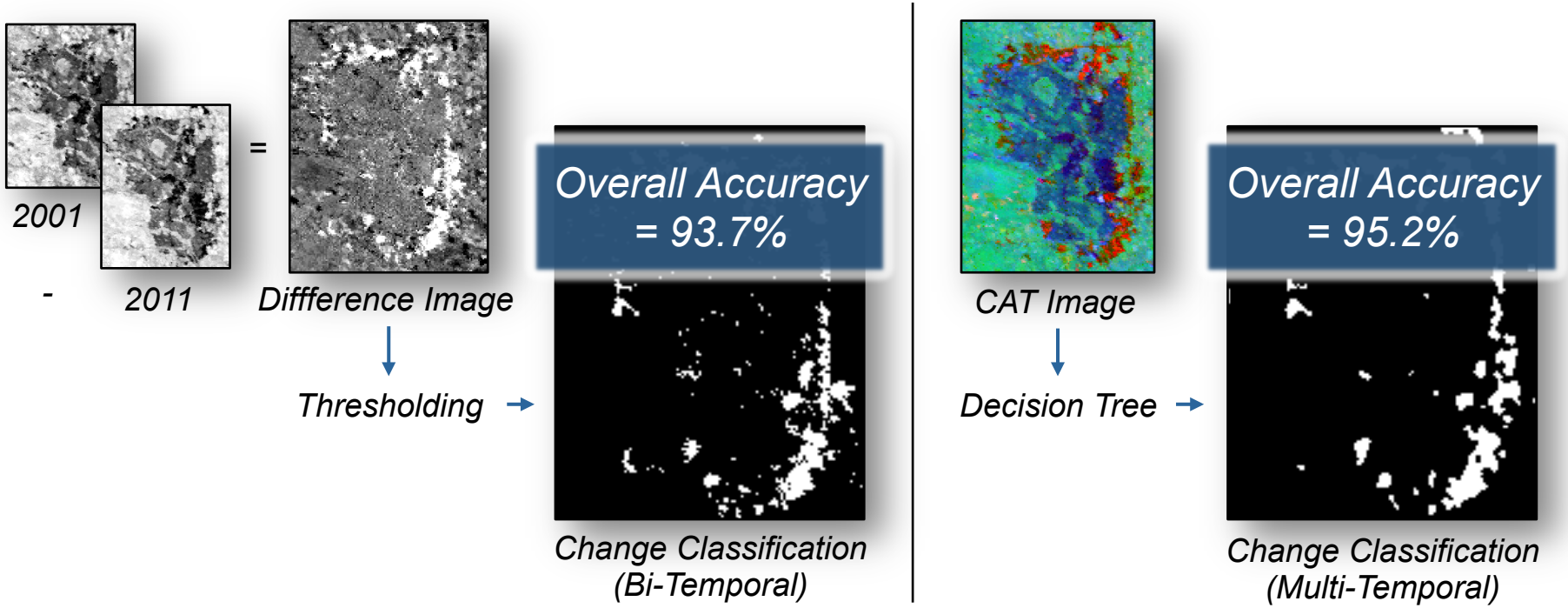
New development (red) in Alberta's oil sands

gation in Alberta's cultural region, g new fields (white)

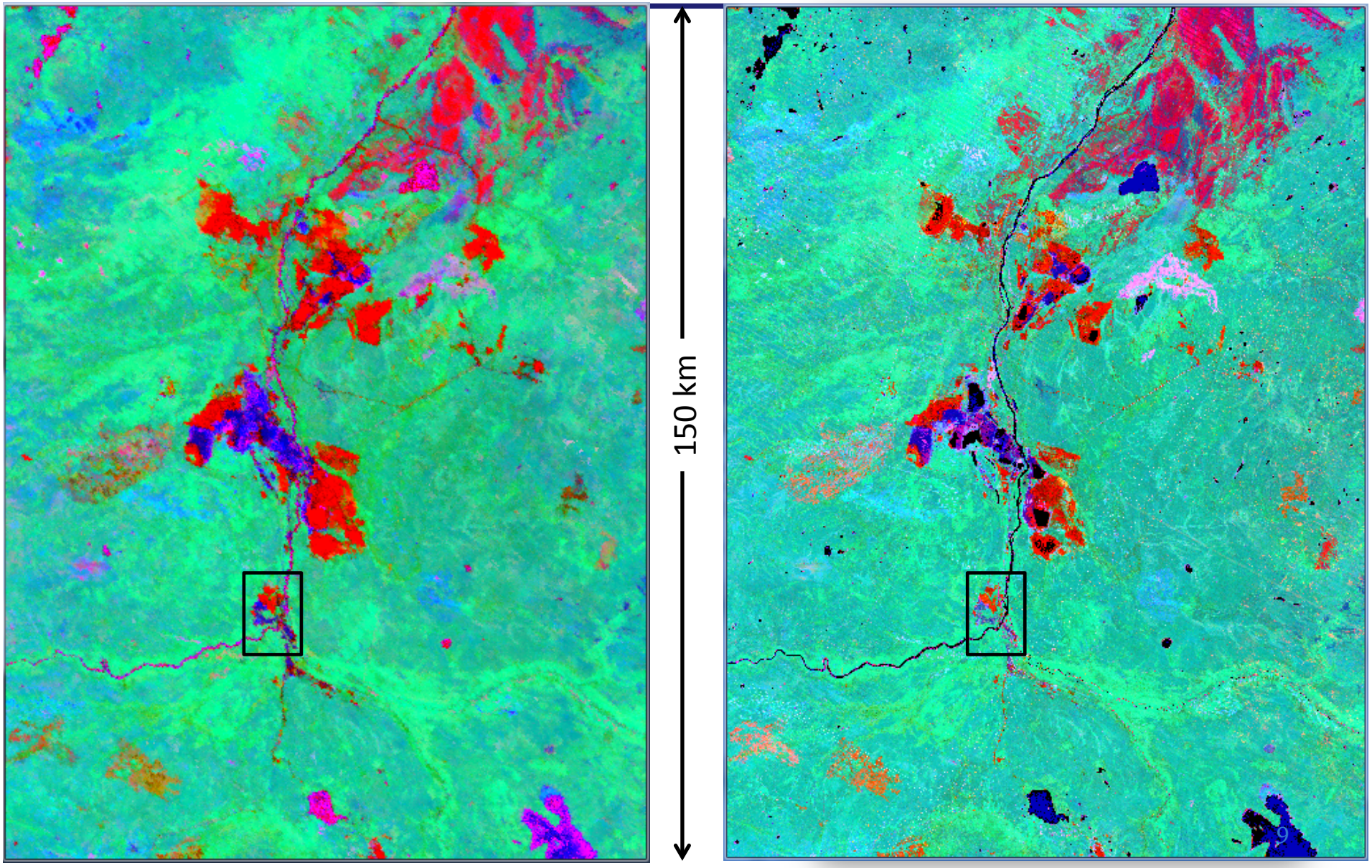
Results: Quantitative Analysis

Case study: quantitative analysis of new urban development around the city of Calgary, 2001-2011

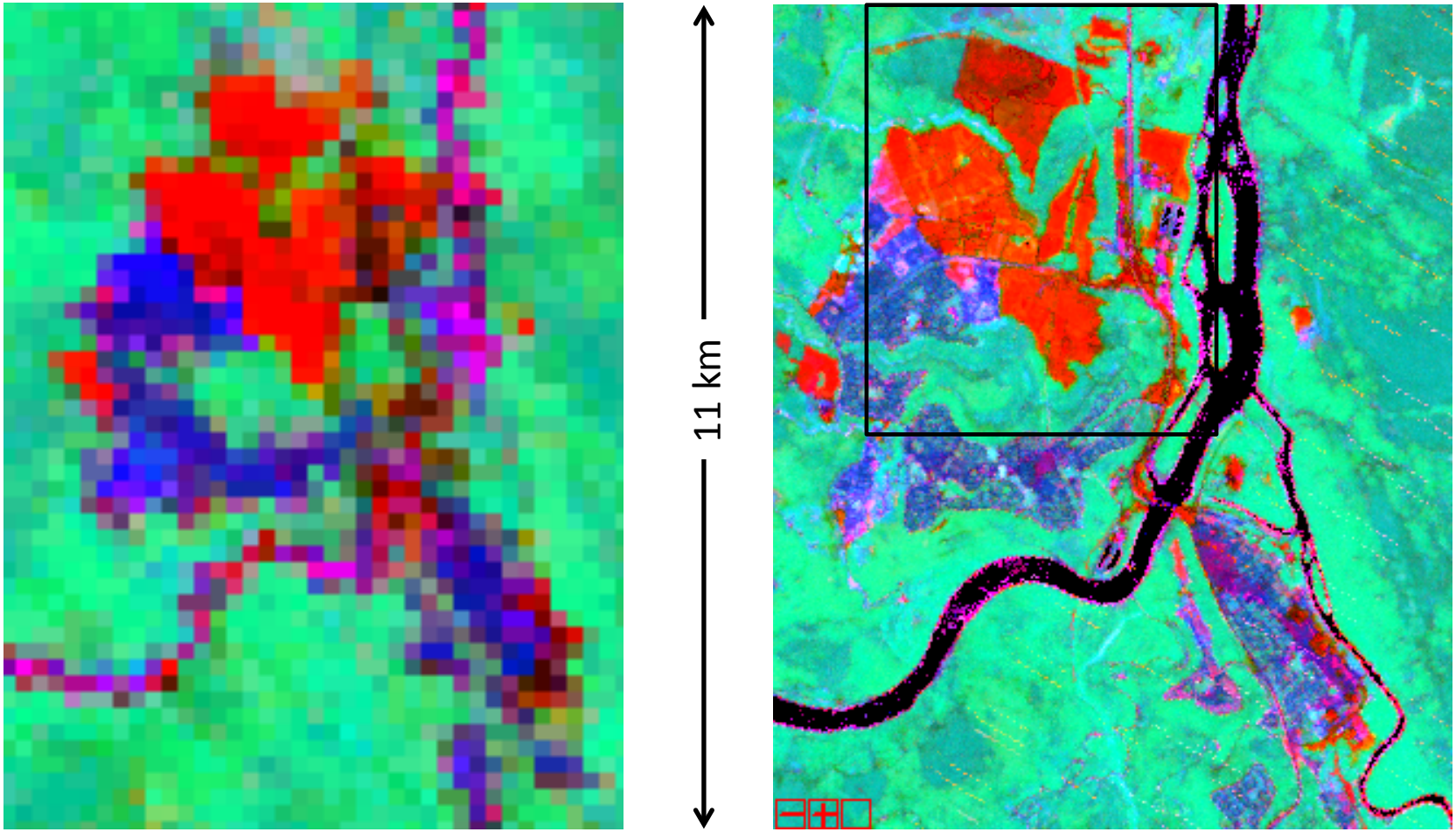
Two change classifications – 1) CAT Transform variables, and 2) using a before/after approach



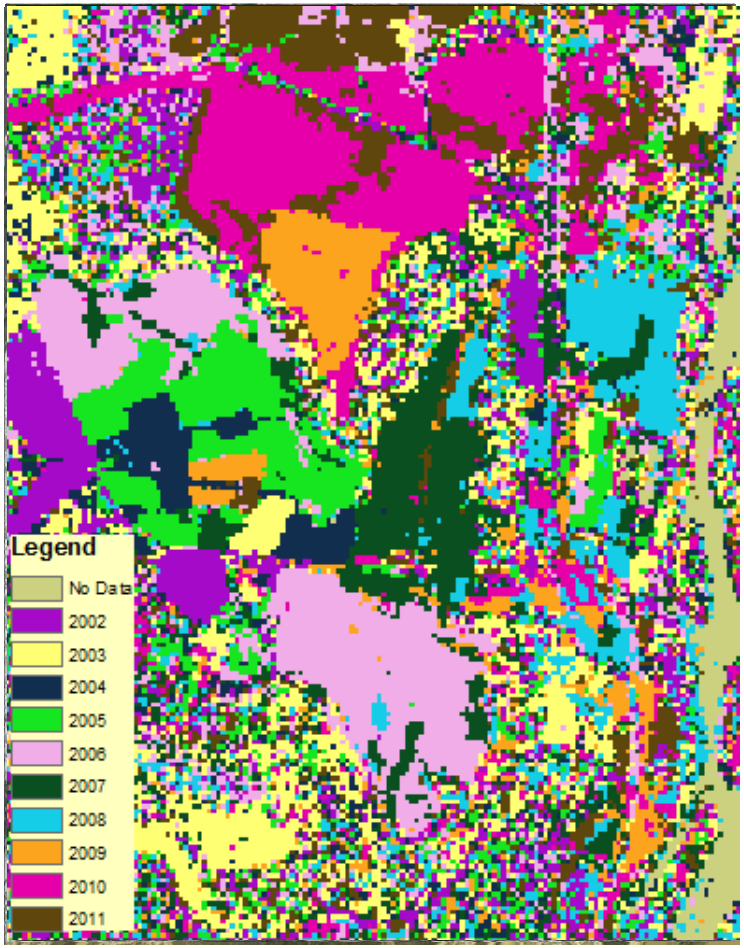
Results: MODIS vs. Landsat



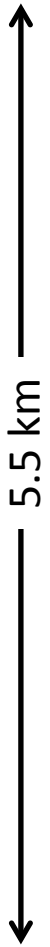
Results: MODIS vs. Landsat

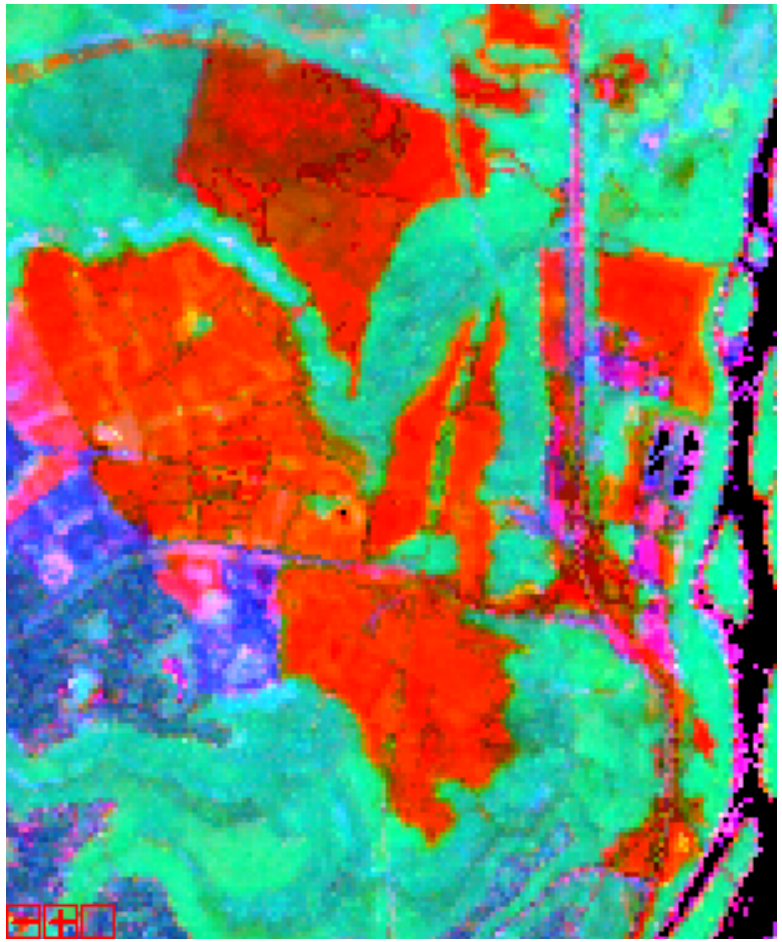


Results: Landsat



Year or change





CAT Image

Conclusions 1/2

Using the CAT transform, it is possible to compress the change information contained in a multitemporal stack of satellite images spanning several years into just one image.

The CAT transform creates a striking color visualization where changes involving vegetation loss or gain, sudden and gradual, can be easily spotted regardless of when in the period they occurred.

In addition, the three CAT variables (Change, Aftereffect and Trend) are also amenable to quantitative change analysis. The year where each particular change occurred can also be obtained as by-product of the CAT transform.

Conclusions 2/2

The CAT transform can achieve consistent results across different sensors and scales in temperate areas as shown by the similarity between the CAT images from MODIS NDVI and Landsat NDVI.

The CAT transform can be used as a means of identifying and pre-screening training areas for supervised change analysis. It also has potential as a standard visualization for conveying decadal landscape changes to the public.

Reference

Hird, J.; Castilla, G.; McDermid, G.; Bueno, I. (2015)
A Simple Transformation for Visualizing Non-seasonal Landscape Change from Dense Time Series of Satellite Data.
IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (in press)
DOI: 10.1109/JSTARS.2015.2419594

UNIVERSITY OF CALGARY

NSERC CRSNG

Natural Resources Canada | Ressources naturelles Canada

Canada

The Department of GEOGRAPHY

Thank you!

F³GISci

Foothills Facility for Remote Sensing and GIScience