



INFORMATION SYSTEMS

# Asset Monitoring and Deforestation Mapping

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# Agenda

- Forest Monitoring – Challenges
- Forest Monitoring – Solution and Product
- Change Detection Methodology and Data
- Asset Monitoring Applications



# Top Challenges to be Addressed

1

## Requires Routine Monitoring

- Routine coverage is expensive from traditional sources (optical)
- Most customers only update every 5-10 years
- Prevents proactive response

2

## Forested Regions = High Cloud Cover

- Customers are used to using optical imagery
- Ineffective in regions that have issues with significant cloud cover
- Customers don't realize they have options

3

## Level of Detail vs. Coverage

- Earth Observation a trade off between resolution and coverage
- Being able to determine fine changes can be difficult
- Optical High Resolution Data is Expensive

4

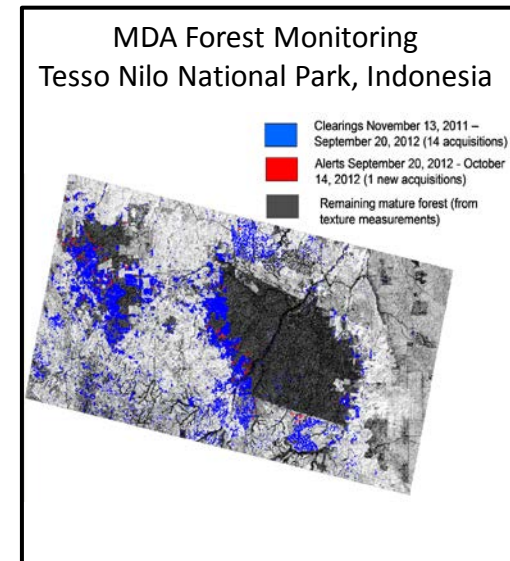
## Lack of SAR Expertise

- Most customers are not SAR experts
- Lack ability to process SAR imagery
- Try and do manual rather than algorithmic analysis



# MDA FOREST MONITORING SOLUTION

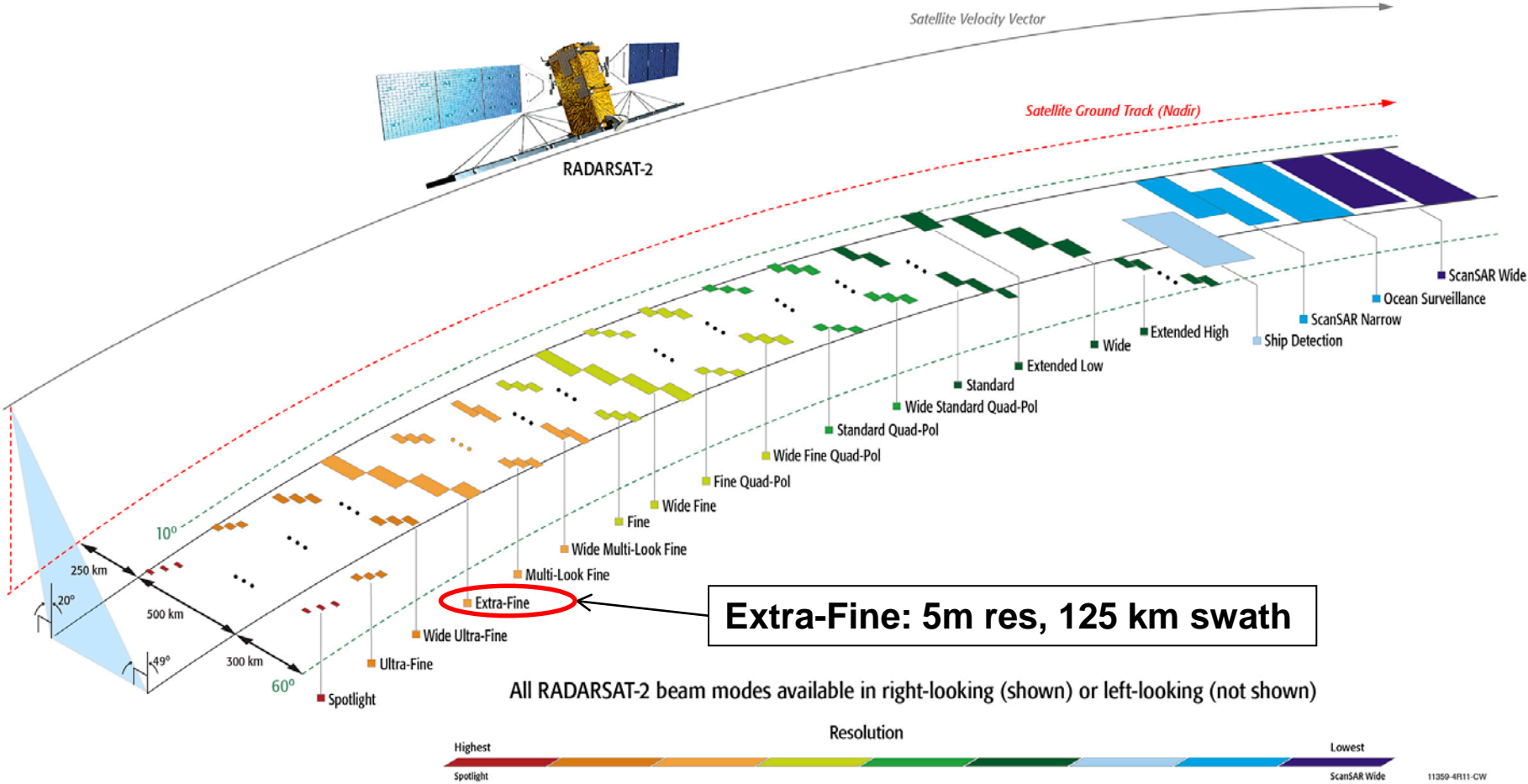
- Space-based, automated forest change detection solution
- Cost-effective option for routine, reliable, high resolution monitoring of large forest areas



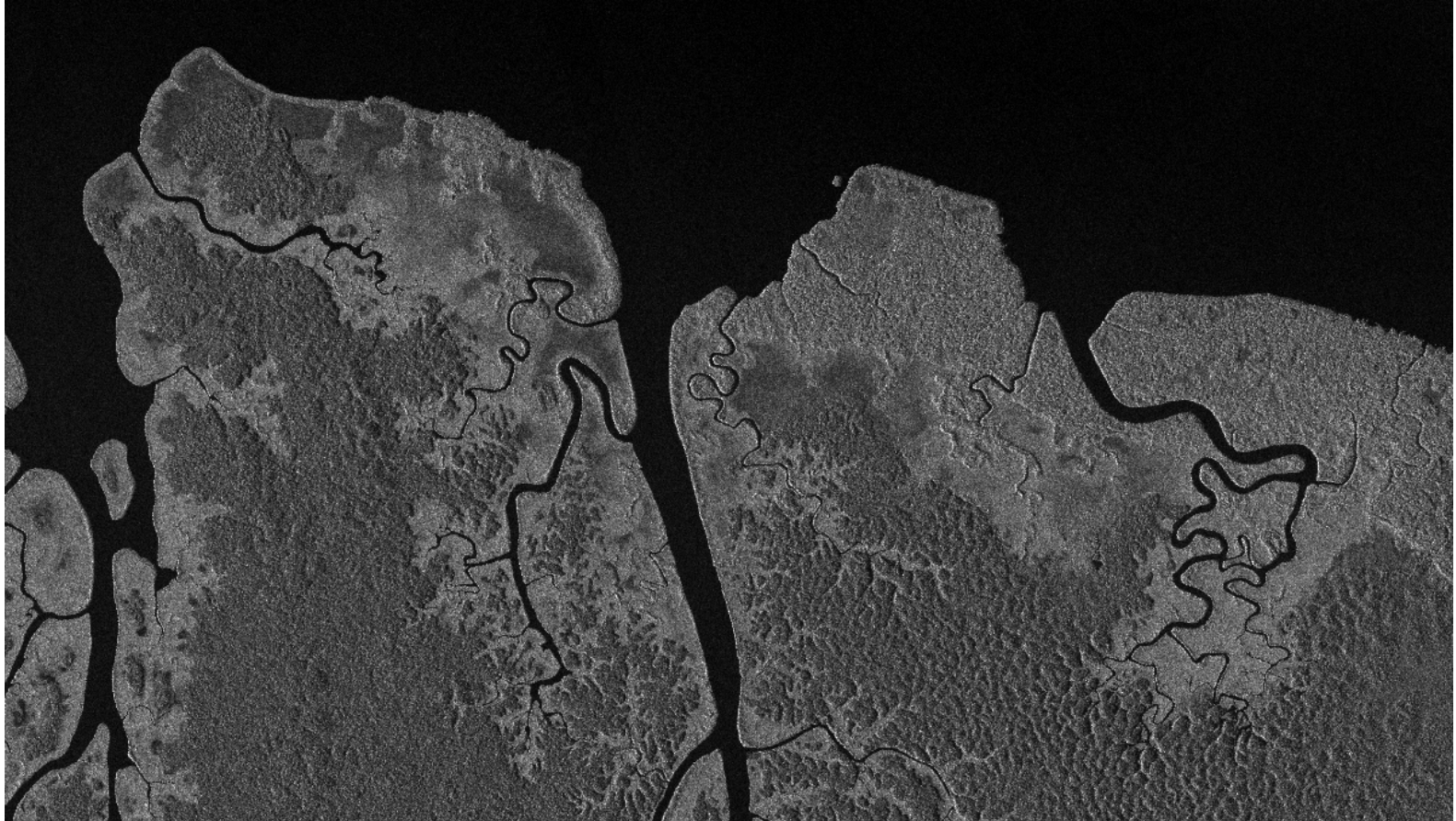
# Data and Methodology Considerations

- **Data for Change Detection**
  - Wide area coverage is typically important
  - High resolution data is ideal
    - Canopy structure only detected at 5 m resolution or better (with change detection)
    - Urban infrastructure: 3m resolution can be needed
    - Enables the detection of a larger number of features, such as narrow roads, airstrips and point targets
- **Methodology**
  - Automated, stack-based change detection can detect subtle changes high resolution SAR data

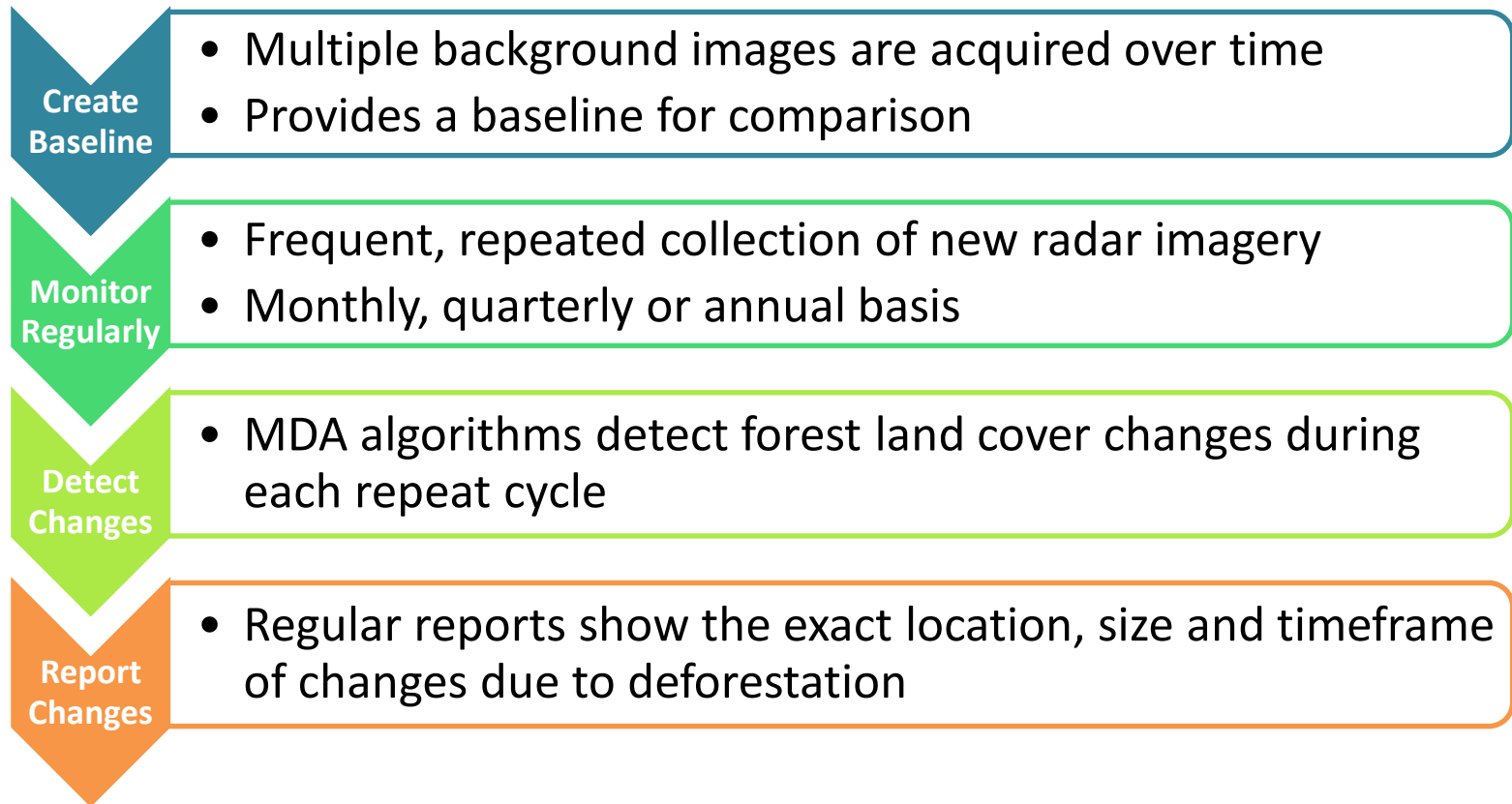
# RADARSAT-2 Extra-Fine combines high resolution and wide swath



# Extra-Fine Beam Mode Sample

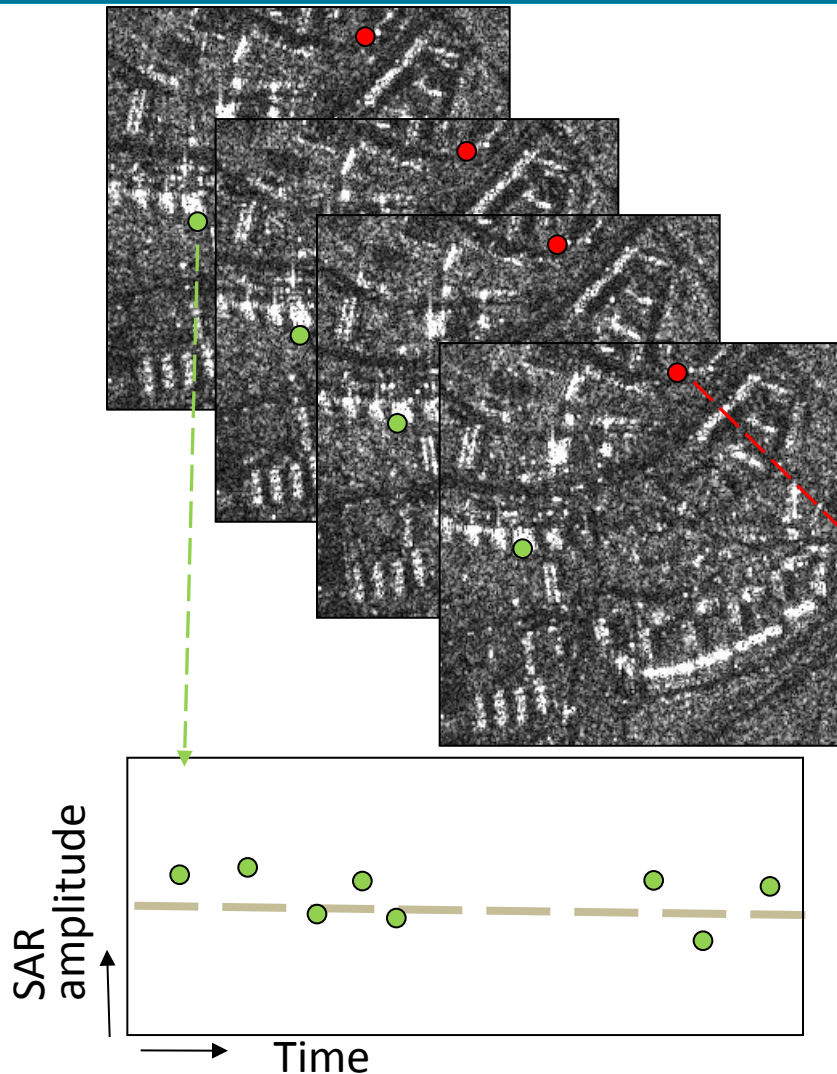


# Deforestation Detection Methodology





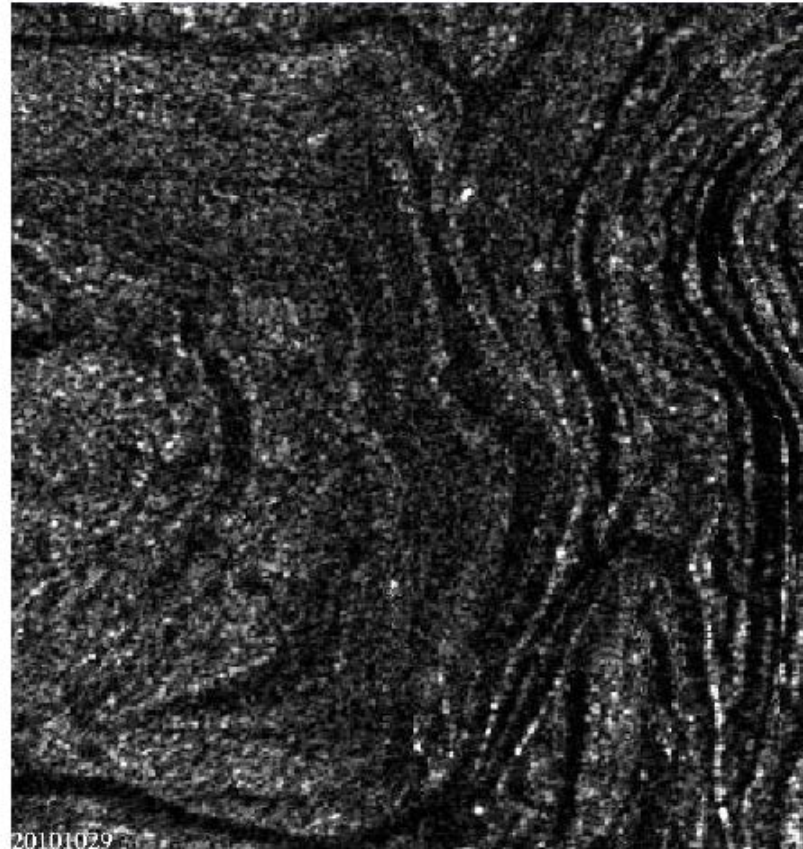
# Stack-Based Change Detection



- A Stack is a set of images having identical geometry
- Stack-based approach allows
  - Filtering of speckle noise from individual acquisitions
  - Improvements in accuracy

# Change Detection Preprocessing Overview

- **In-Stack coregistration**
  - In-stack implies that all images have same incidence angles, pass direction, look direction, beam mode, and align each other
  - Geometric accuracy in sub pixel (i.e. 0.15 rms)
  - Tie point based polynomial correction using correlation method in Range Doppler Coordinate (RDC)
  - Provides input for all kinds of change detection processing



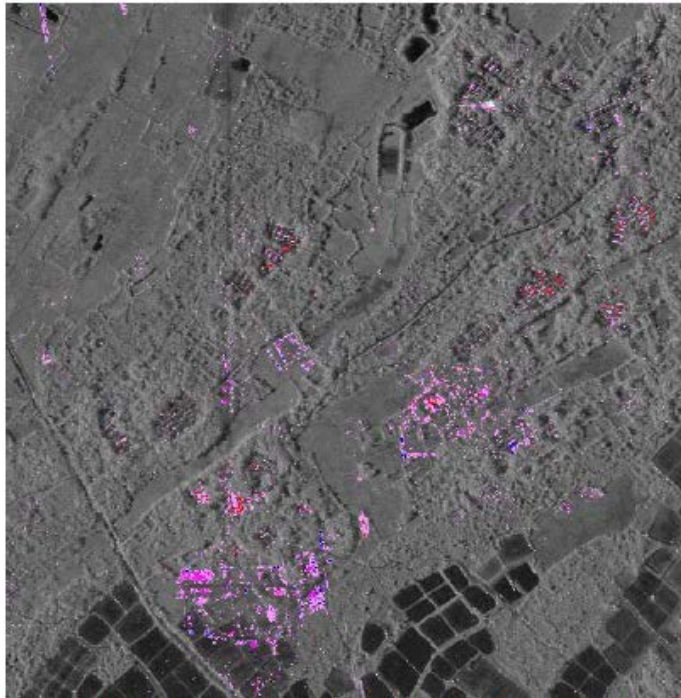
# Detection Method

## Stacked Based Change Detection Products Description

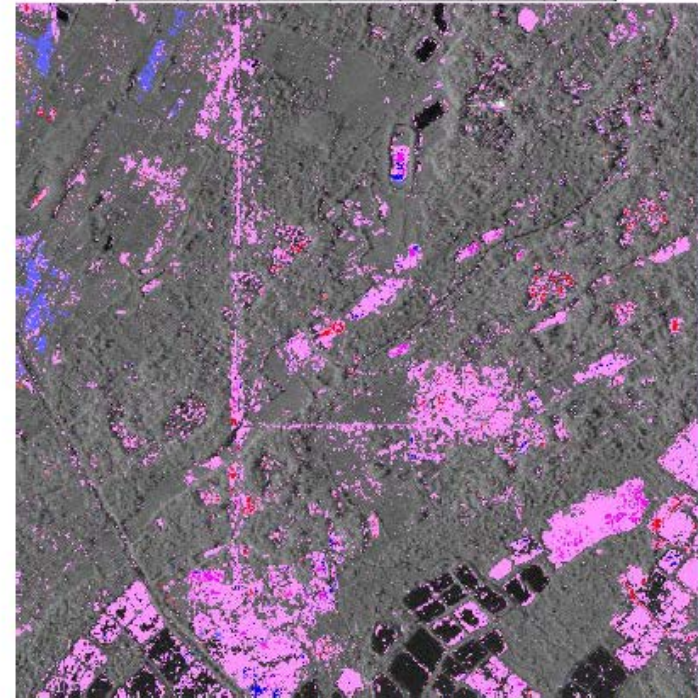
Color coded classification image

- 3x8 RGB GeoTiff image
- Classify each detected pixel into 7 classes
- Screening the detected pixels using a threshold backscatter

1, 1, 255	255, 1, 1	255, 1, 255	180, 180, 255	255, 180, 180	255, 158, 255	R=0-B=255 Backscatter in black & white
Persistent change appear case	Persistent change disappear case	Rapid change	Likely persistent change appear case	Likely persistent change disappear case	Likely rapid change	Unchanged case

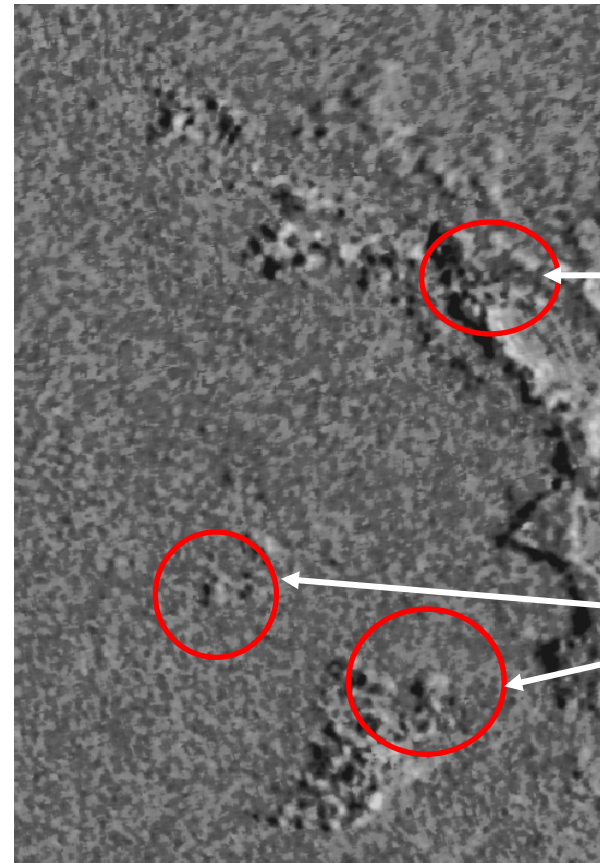
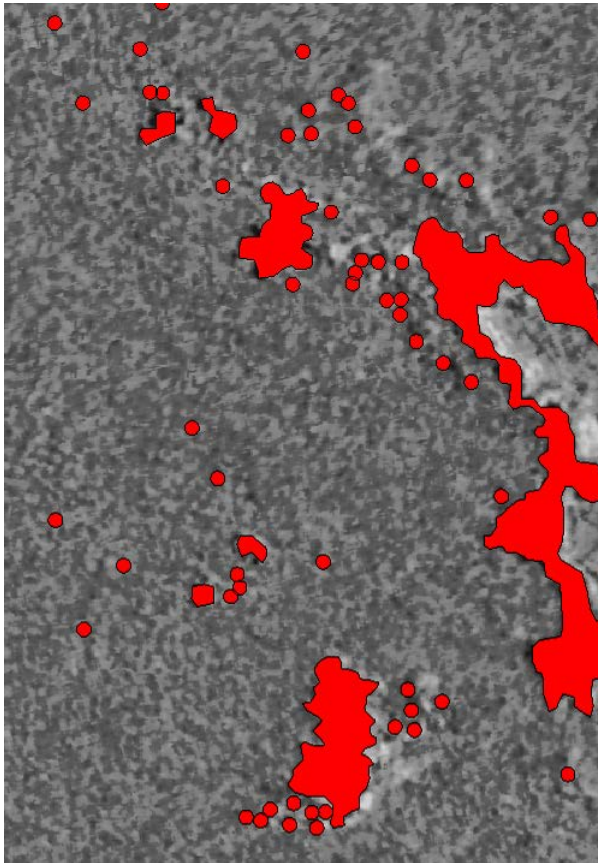


Color coded classification image with 0.7 in screening threshold



Color coded classification image with 0 in screening threshold

# Spotlight Change Image Example

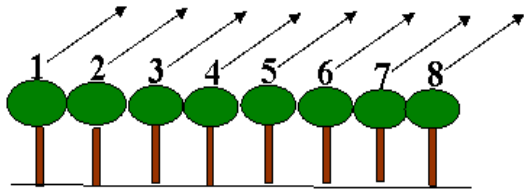


New cuts in  
plantation

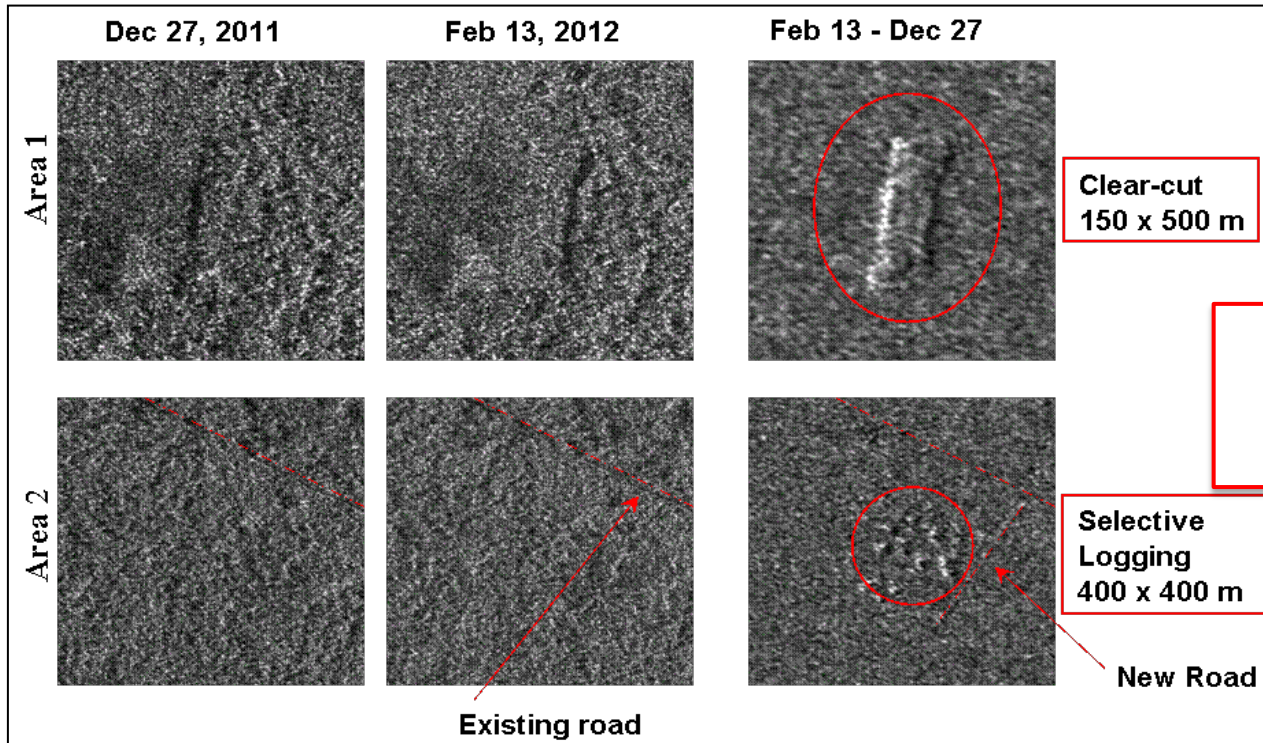
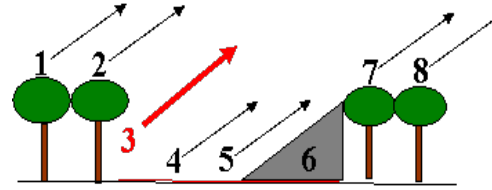
Removal of  
trees

# Canopy Change Detection

Before the Change



After the Change

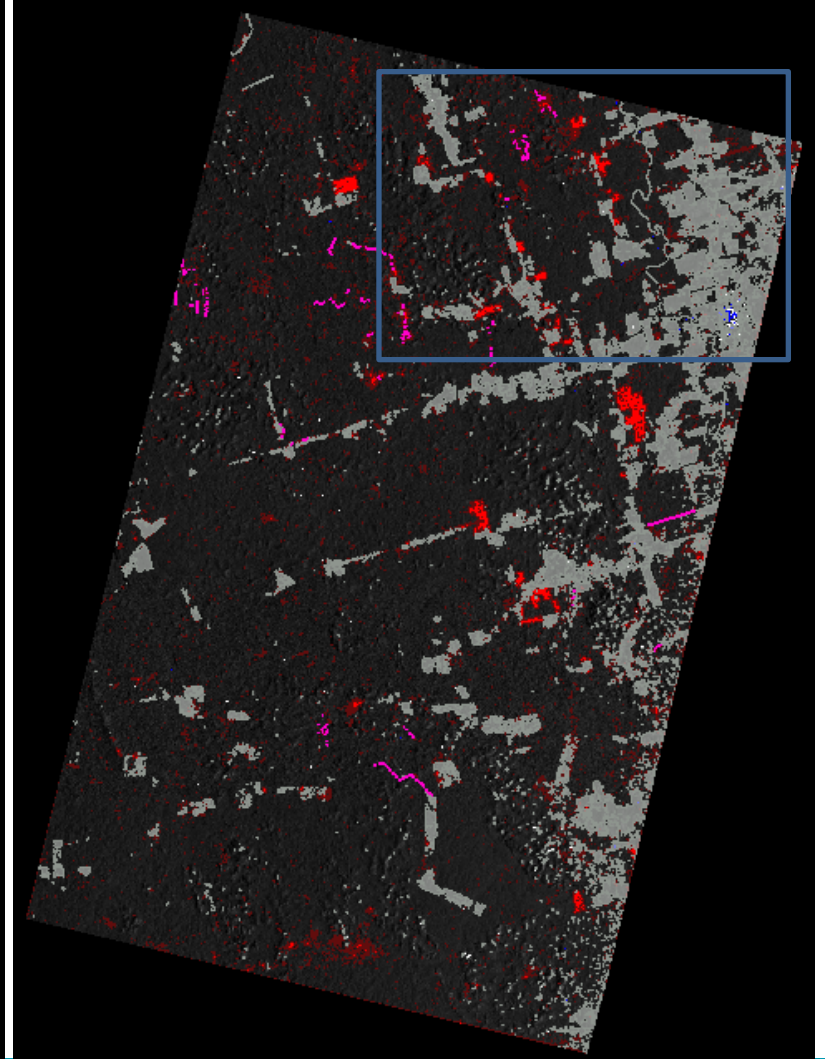
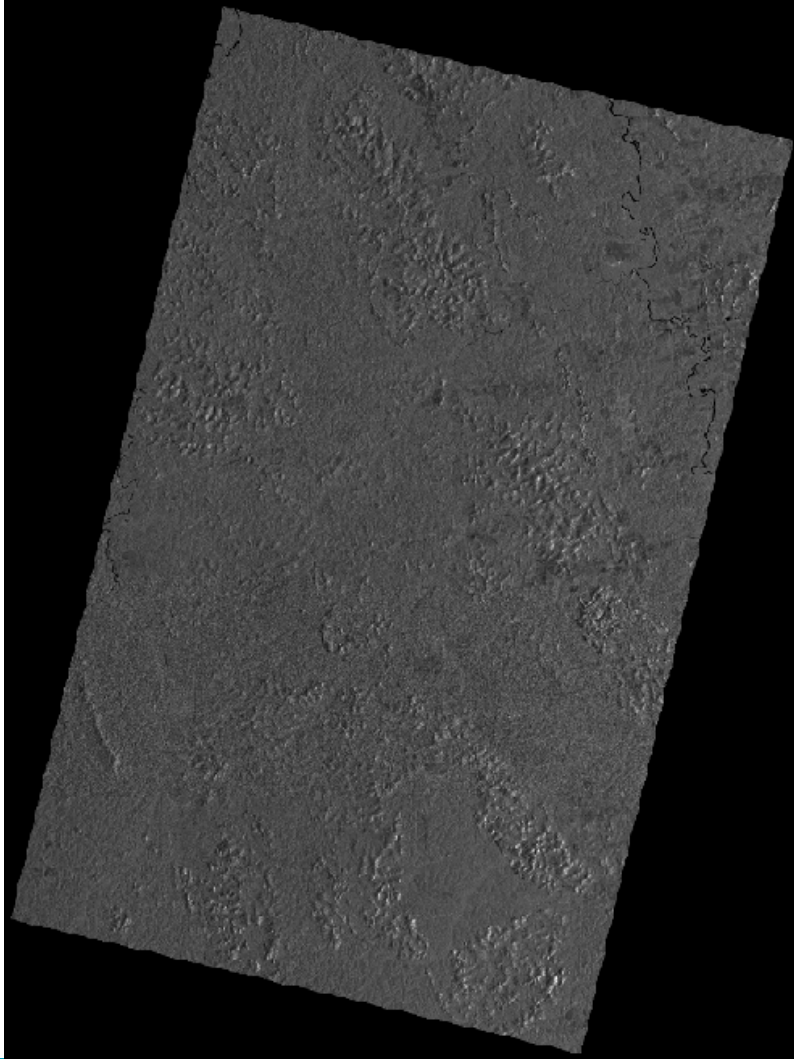


Selective logging detected!

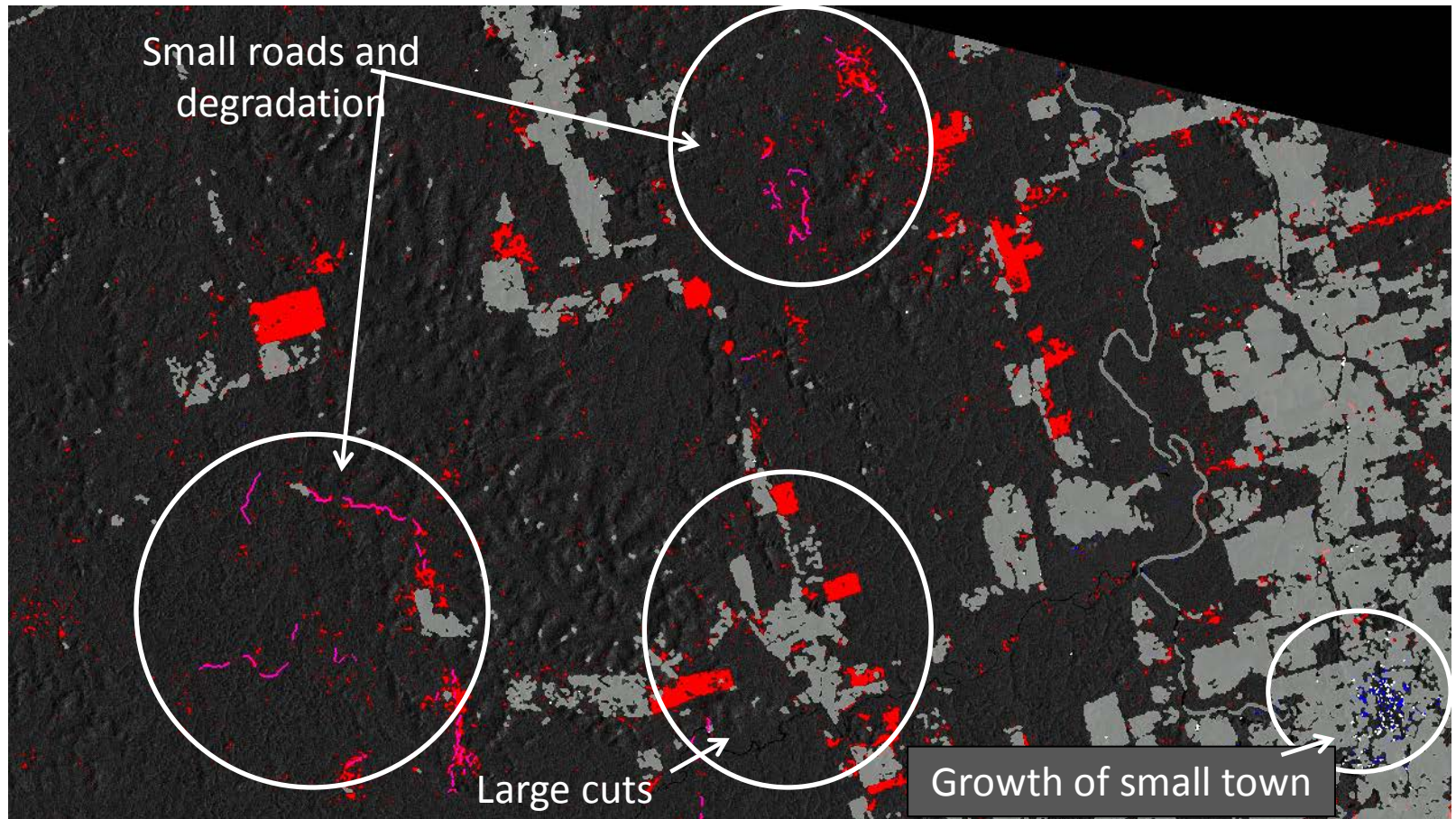


# FOREST MONITORING EXAMPLES

# Detections in Pará, Brazil



# Detections in Pará, Brazil





# Validation

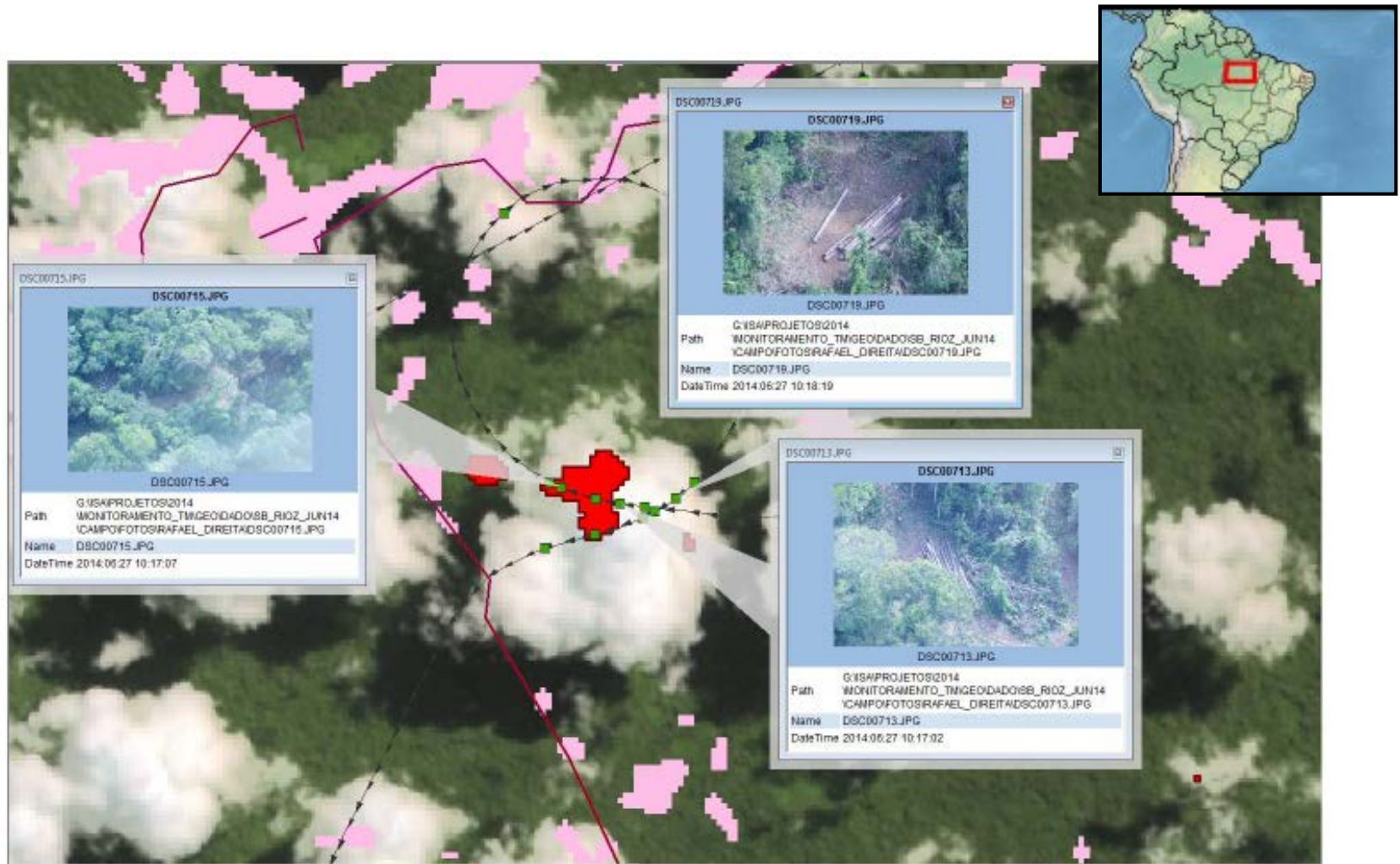
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- Papers published

- USE OF RADARSAT-2 FOR DETECTION AND MAPPING OF LOGGING WITHIN THE AMAZON (MDA, Greenpeace, 2014, XI SENGEF)
- FOREST LOGGING ALERTS FROM RADARSAT-2 SAR DATA (MDA, Greenpeace, 2014, XI SENGEF)

- Detection accuracy: 89%

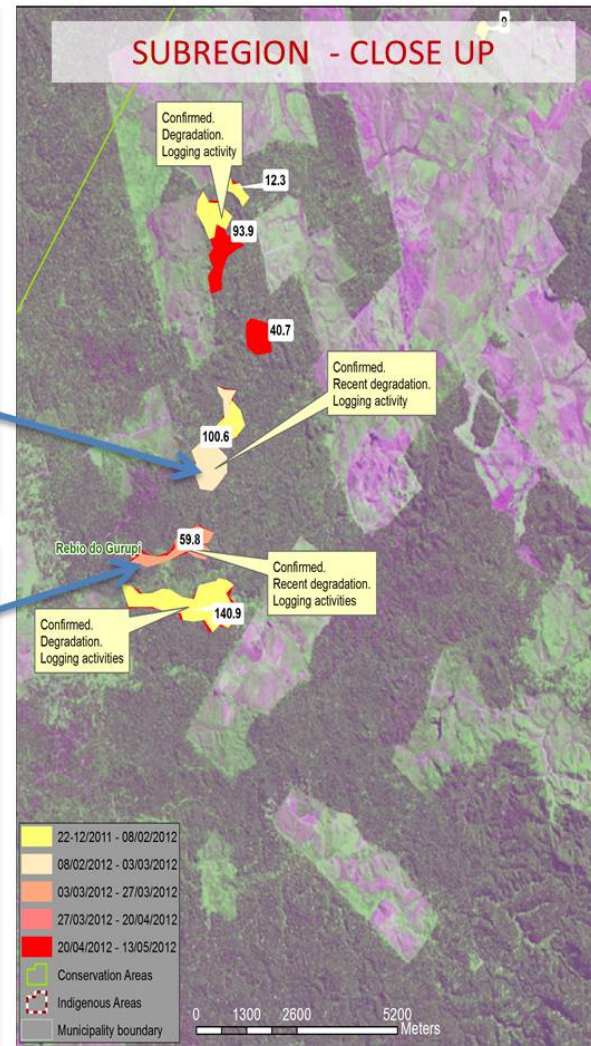
# Validated Detections



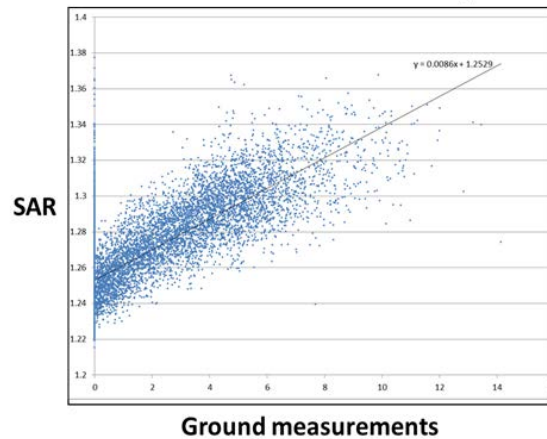
RADARSAT-2 Data and Products © MacDonald Dettwiler and Associates Ltd 2012 – All Rights Reserved. RADARSAT is an official mark of the Canadian Space Agency

Flightlines, photos © ISA, 2014

# Maranhão, Brazil



# Detailed Validation of Low Impact Logging



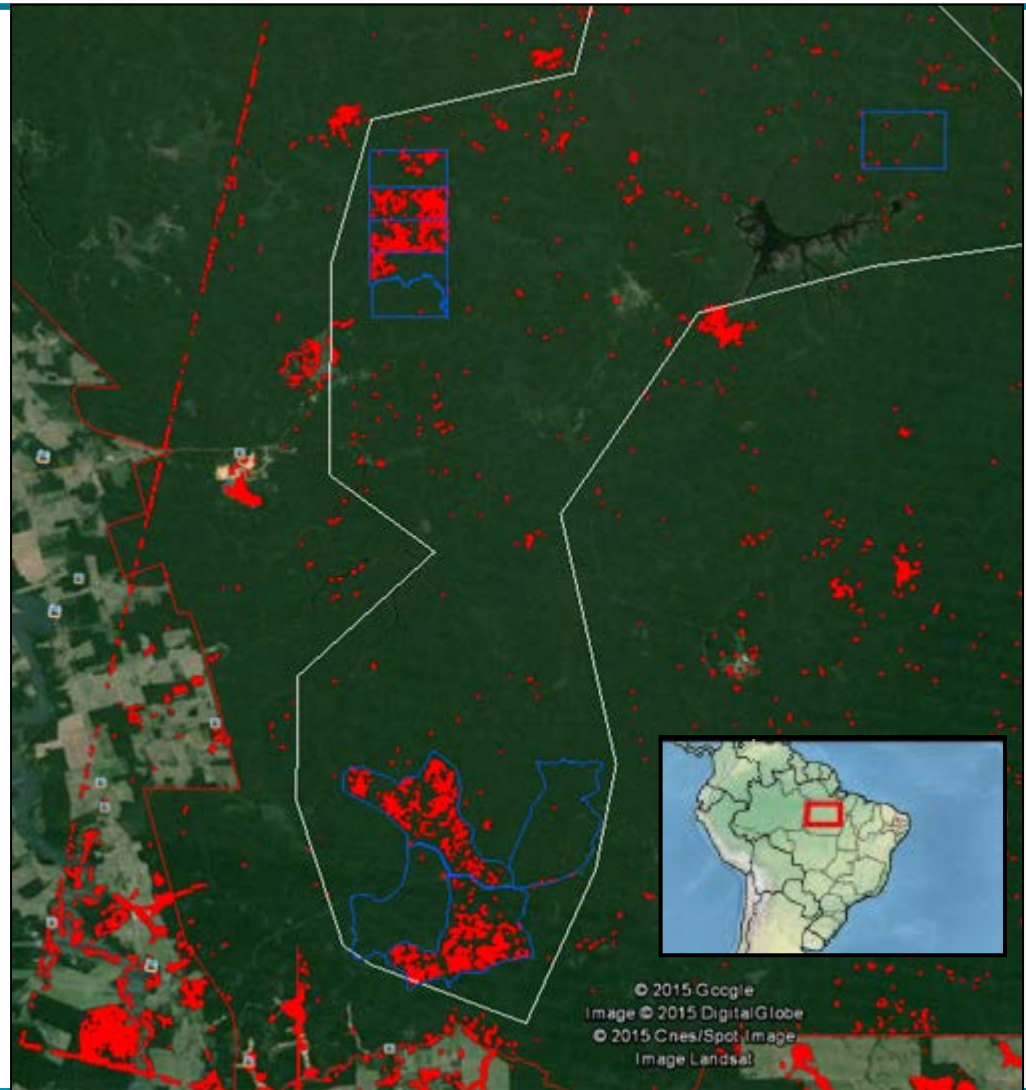
- Logging detected from SAR is well correlated to ground measurements (50 x 50m samples)

 SAR Canopy Change detection

17/12/2011-30/12/2013

 Controlled logging areas

 Protected area

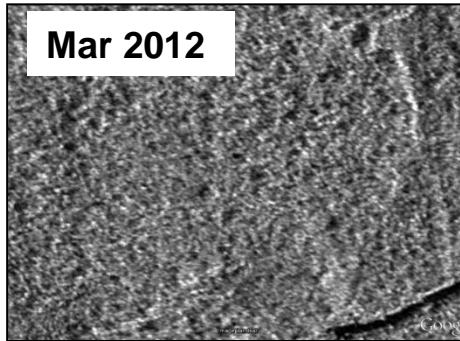


# Asset Monitoring Applications

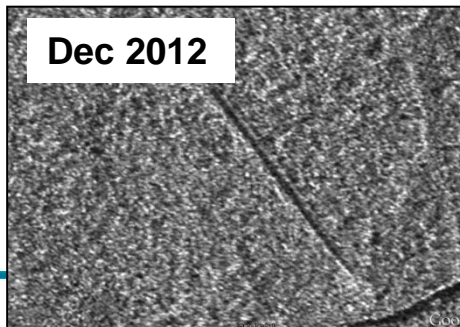
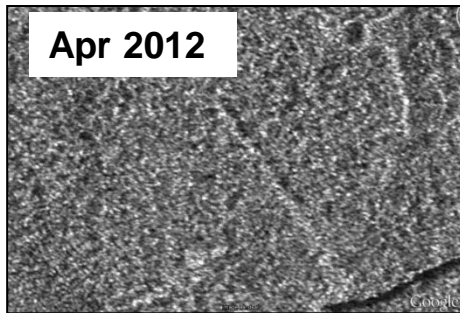
# Detection of Airstrips

## SAR Images

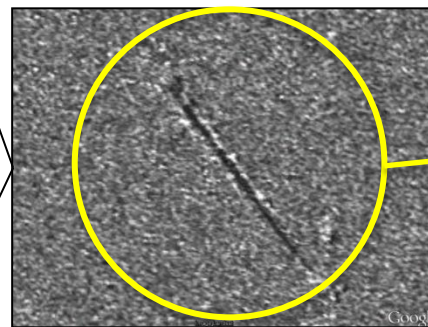
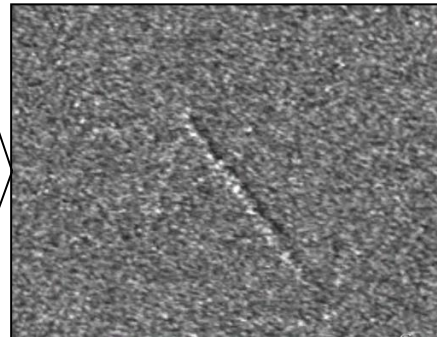
1



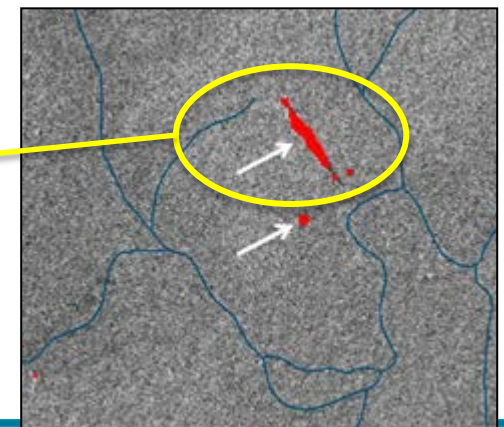
2



## Change Images

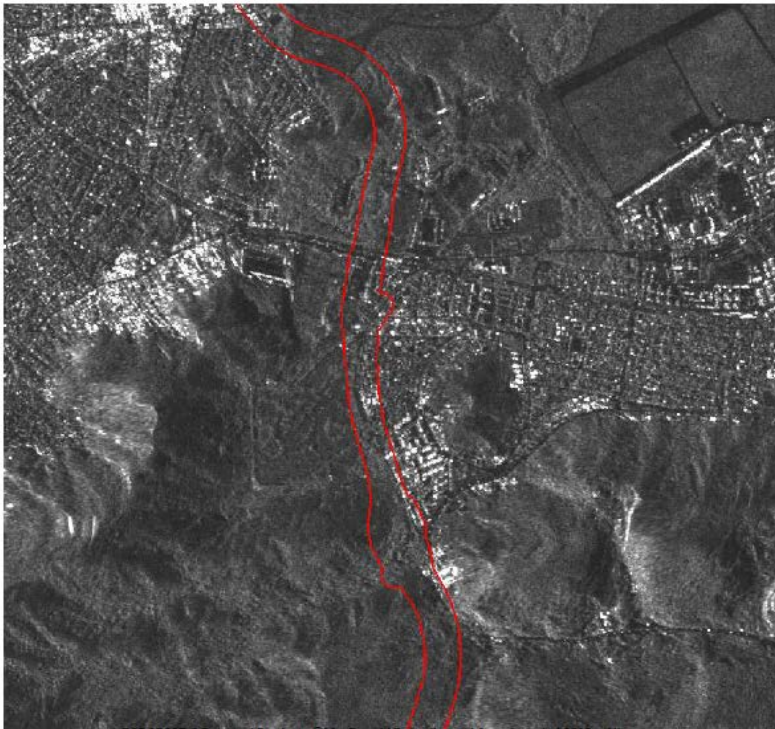


## Automated Detection

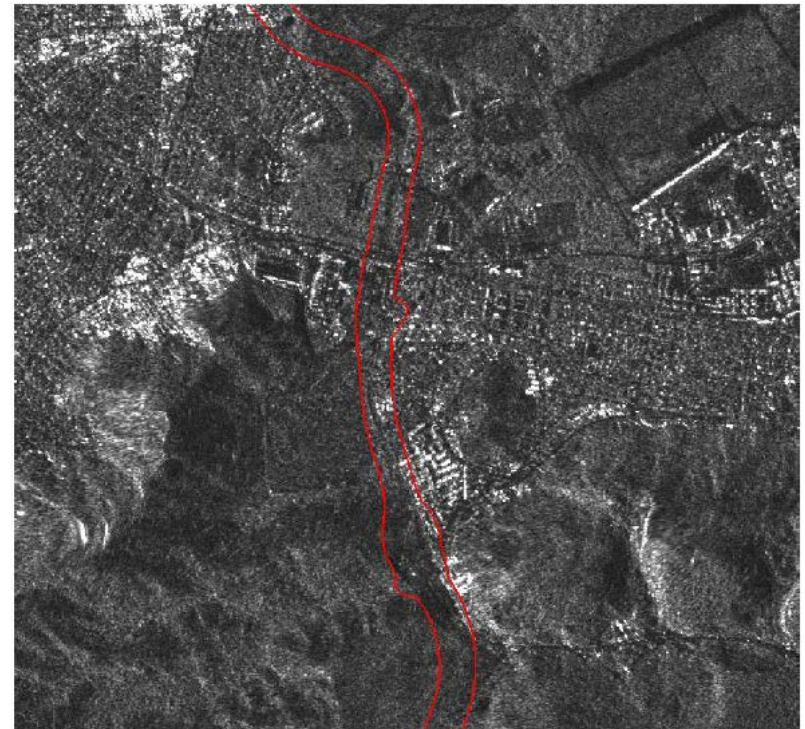


# Transolympic Highway, Rio, Brazil

Area A  
20130205



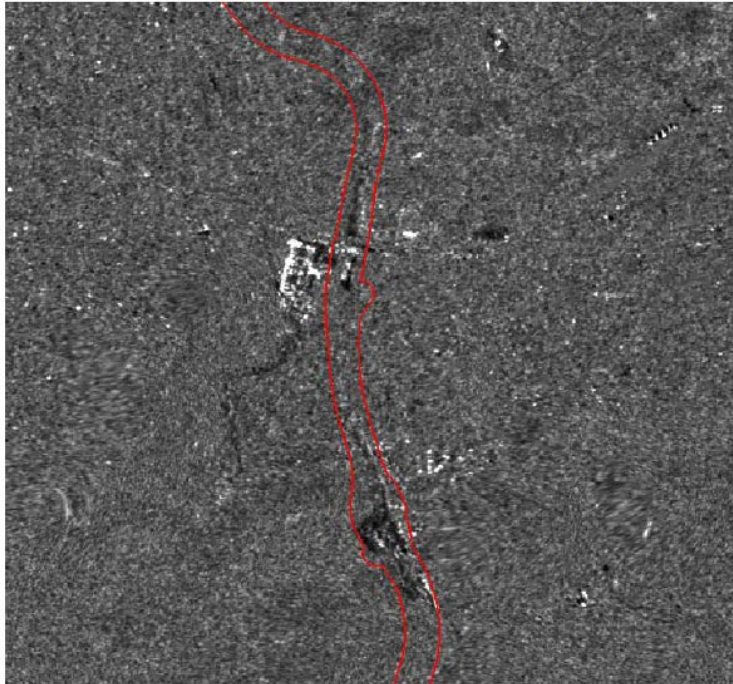
Area A  
20130816



# Transolympic Highway, Rio, Brazil

## Change detection area A

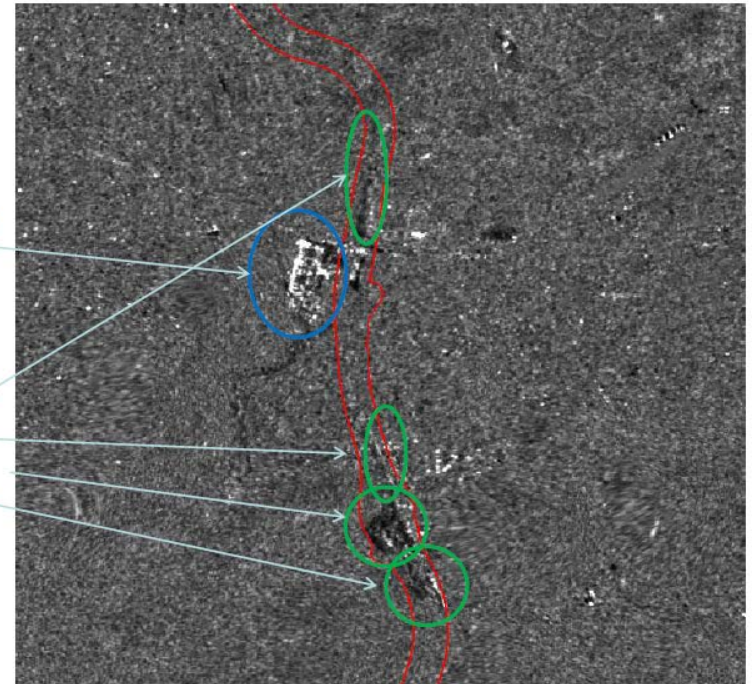
white = increased backscatter  
Black = reduced backscatter



## Interpretation area A

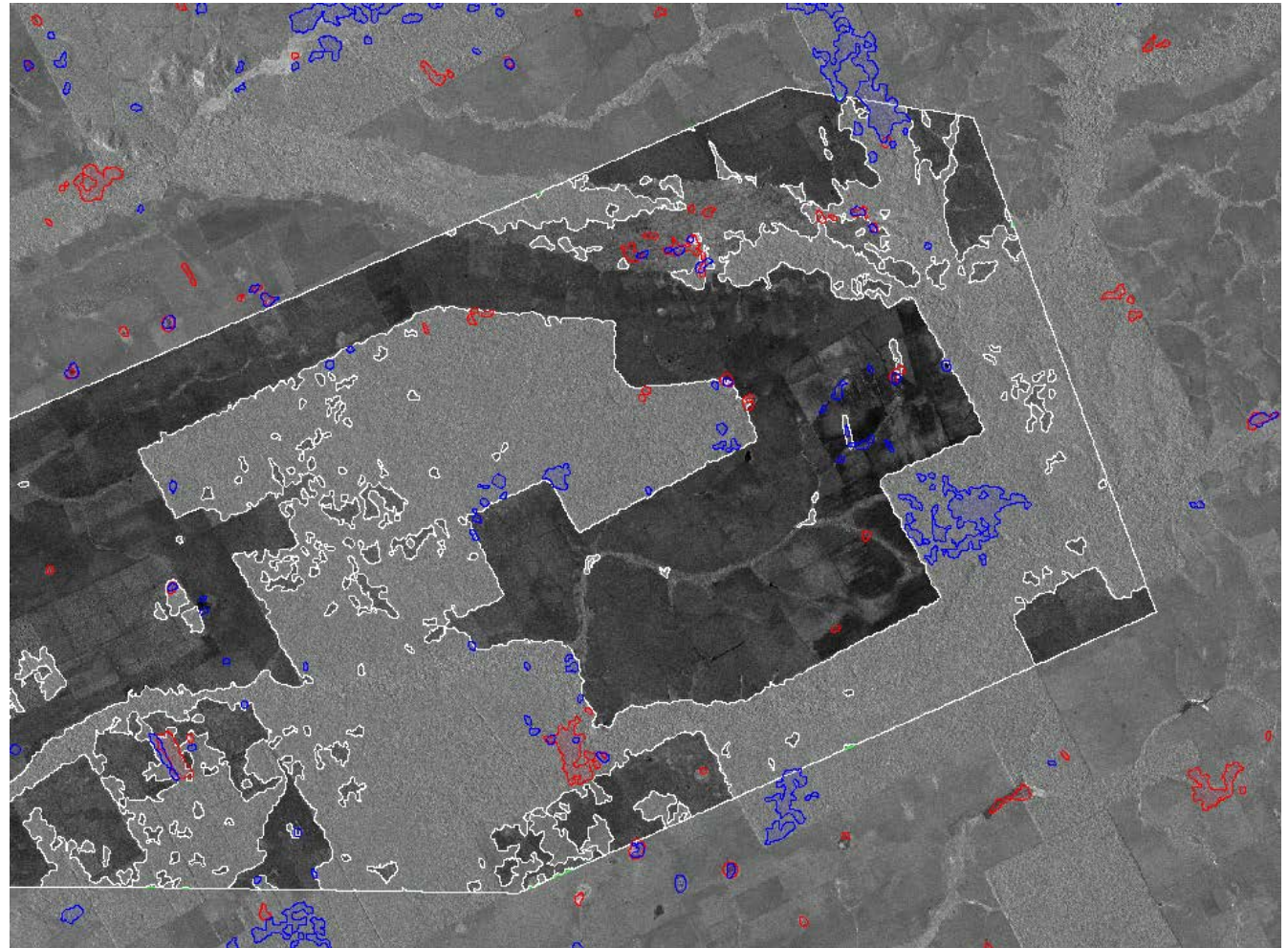
Large new building

Tree removal, surface alteration





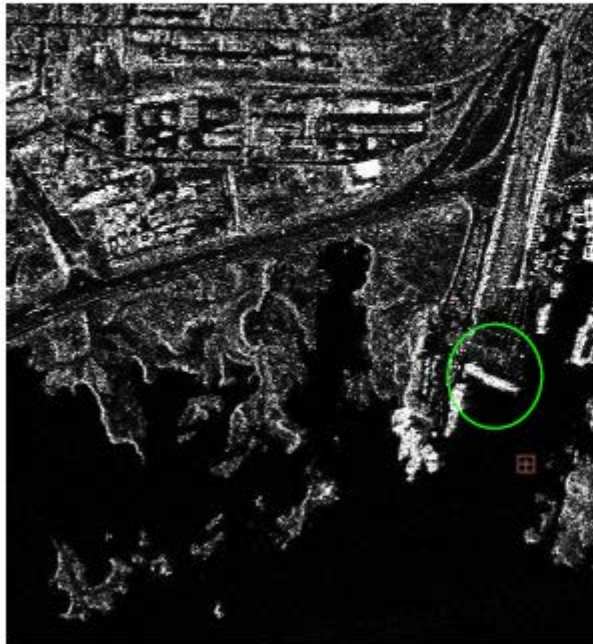
# Farm Monitoring



# Ship Detection

## Cross Stack differential RGB image

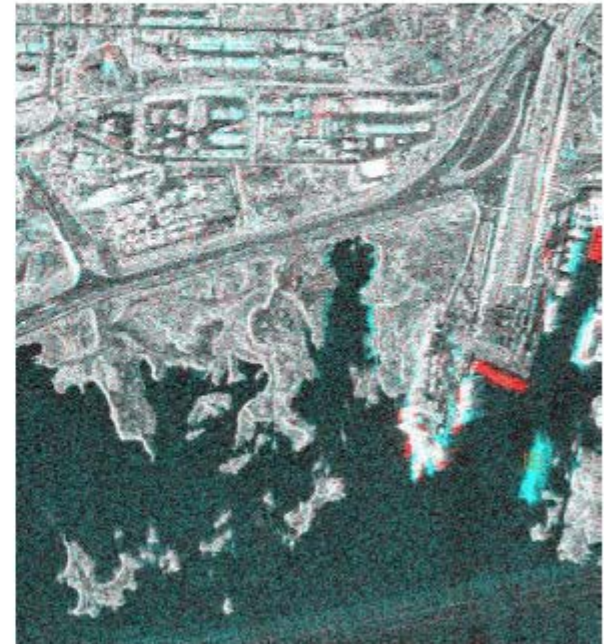
- Differential RGB between stacks
- “Red is fled, blue is new”



20101024\_SLA14AR image



20101031\_SLA6AR image



Diff\_20101024\_20101031\_HH image

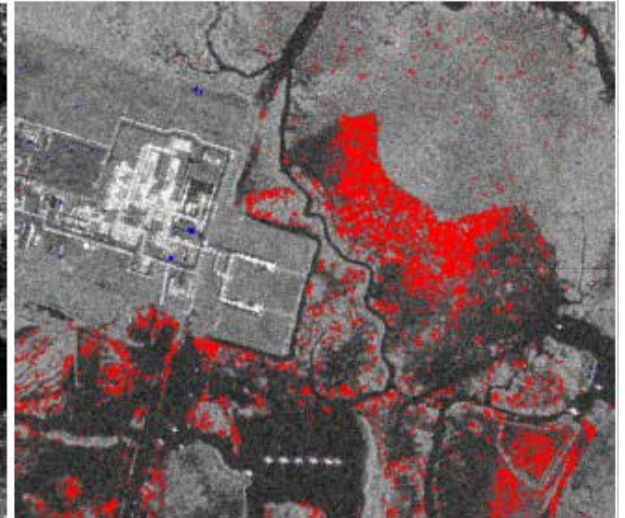
# Flood Mapping



20110323



20110627



20110323\_20110627\_HH\_change\_mask.tif

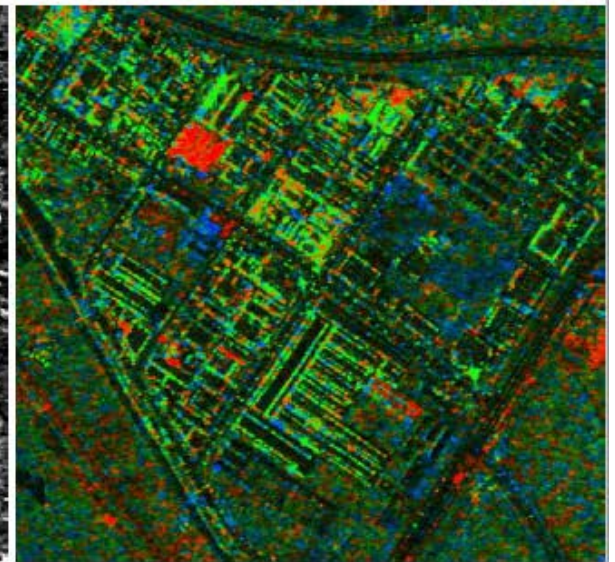
# Urban Construction Mapping



Before



After



Changes

# Change Detection by Year

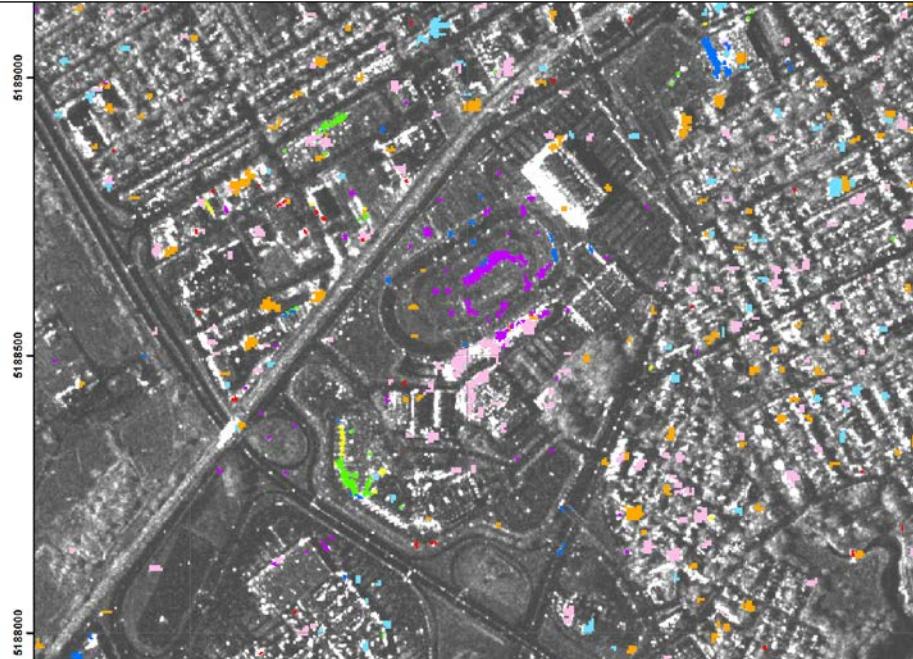
## Legend

### RADARSAT-1 PERIOD

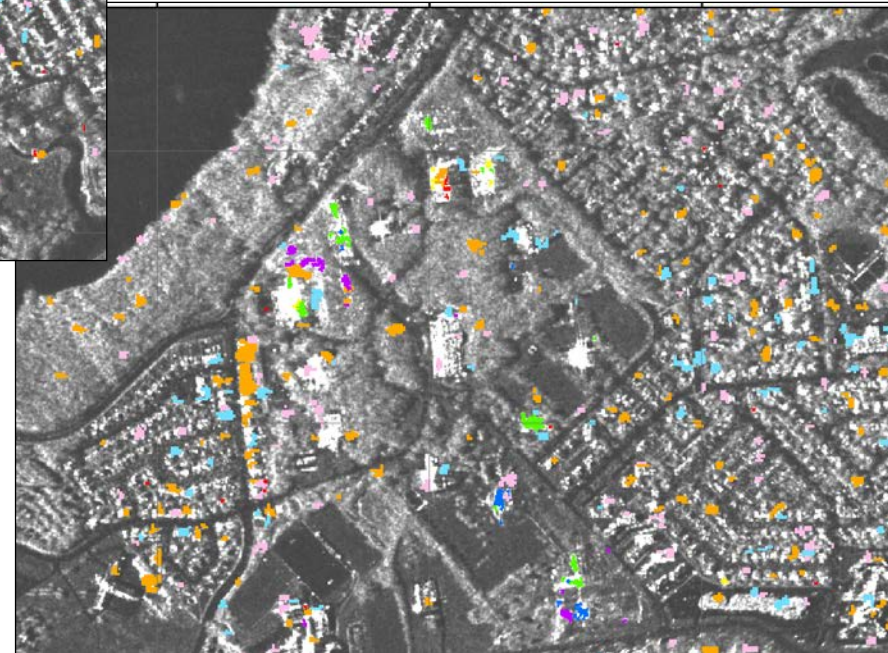
- 1999\_2001
- 2001\_2004
- 2004\_2008

### RADARSAT-2 Period

- 2008\_2009
- 2009\_2010
- 2010\_2011
- 2011\_2012
- 2012\_2013



- Quebec City
  - RADARSAT-1 and RADARSAT-2
- Dates ranging from 1998-2013
  - Change indicated by year





Thank you