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# Large Area Monitoring of Linear Infrastructure using RADARSAT-2

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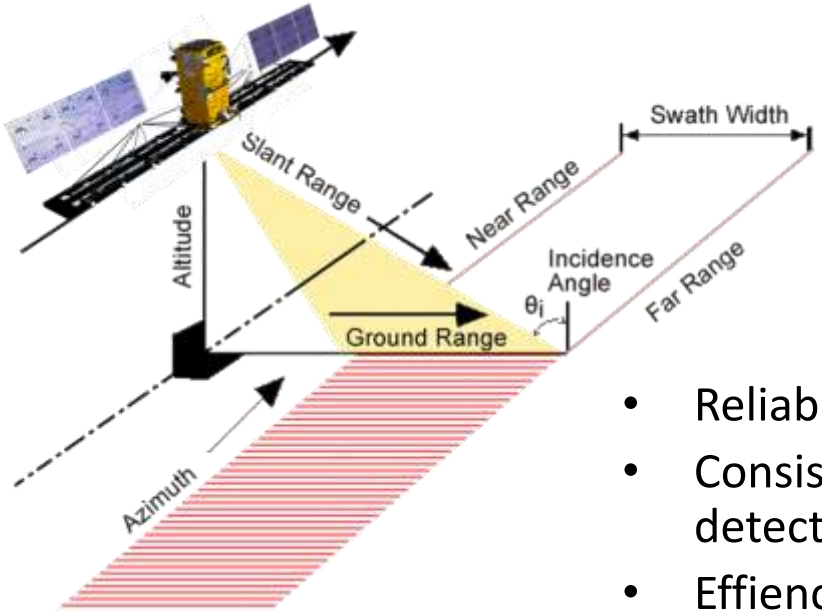
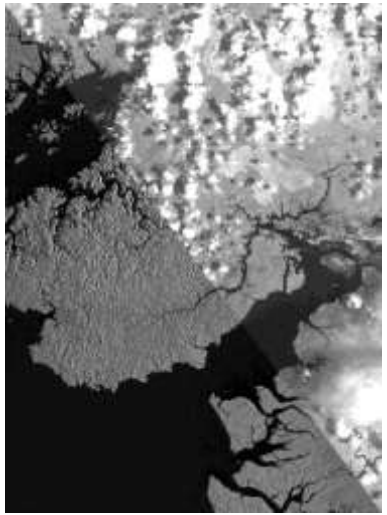
# Content

- Introduction
- SAR, Broad Area Change Detection, Land Surveillance
- RADARSAT-2 capability
  - Unique surveillance capability: XF image mode
  - Capacity and products
- Examples of Alert programs
  - Forest Monitoring
  - Hazards
- Alerts near Linear infrastructure
  - Hazards on or near infrastructure
  - Encroachment, human activity (persistent, random)
  - Deformation, subsidence

# Spaceborne SAR, strengths for land monitoring



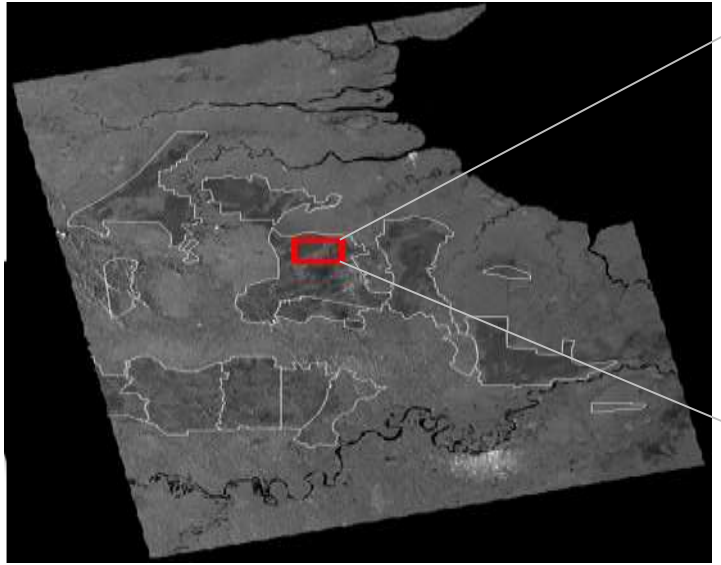

- Reliability of acquisition (99%)
- Consistency of change detection capability
- Effiency and automation
- Deformation measurement



# RADARSAT-2 XF (Extra Fine)

## Large images (125 x 135 km), High resolution (5 m)

**Very dense information!**



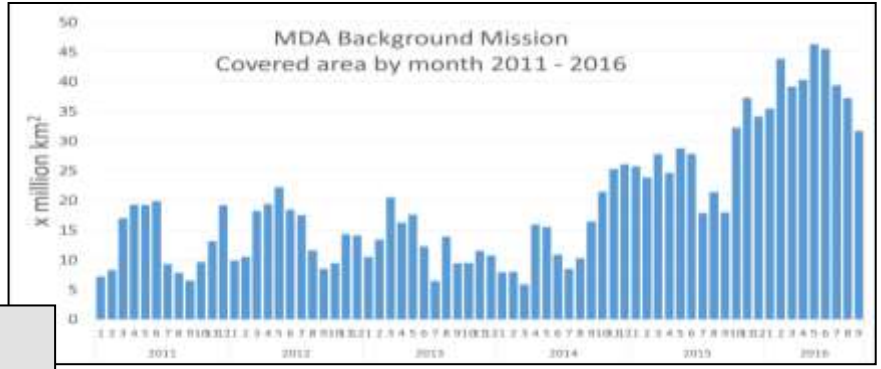
RADARSAT-2 XF March 5, 2015

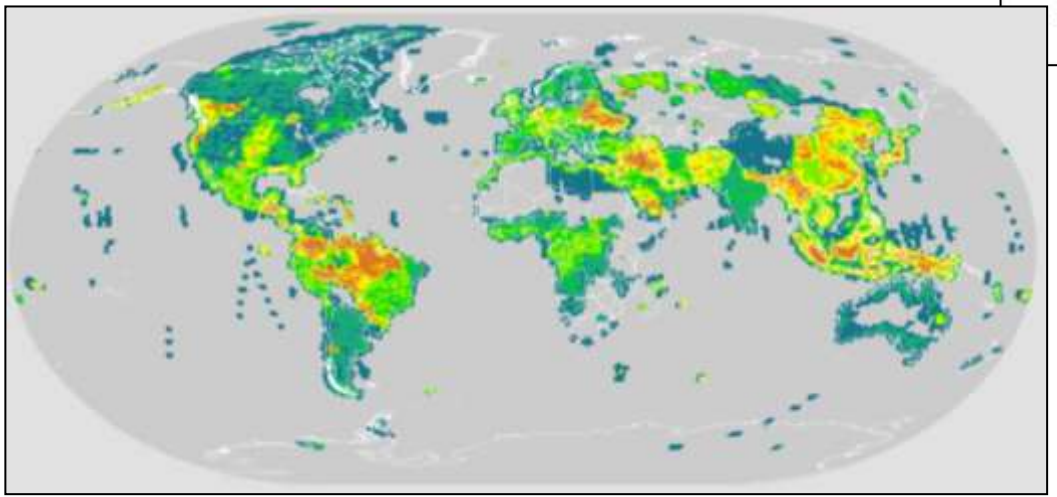
Sample spacing: 2.66 m (sl.range) x 2.50 m (azimuth)
**26784** samples x **54145** lines = **1.45 Billion pixels**

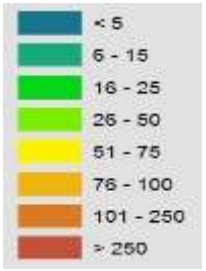
| | Inc. angle near edge | Inc. Angle far edge | Ground Resolution far edge (m) | Azimuth resolution (m) | Swath (km) | NESZ (dB) |
|---|---|---|---|---|---|---|
| XF0W1 | 21 | 32.4 | 5.8 | 4.5 | 169 | -21 |
| XF0W2 | 31.3 | 38.9 | 4.9 | 4.5 | 130 | -21 |
| XF0W3 | 38.1 | 44.2 | 4.4 | 4.5 | 120 | -21 |
| XF0S7 | 44 | 48.8 | 4.1 | 4.5 | 108 | -21 |

# Coverage and volumes of exact-repeat RADARSAT-2 5 m resolution archives (since 2011)

- Total archive coverage 1.33 B km$^2$
- 359 M km$^2$ in 2016
- 30-40 M km$^2$ / month in 2016
- Stored in Canadian archive





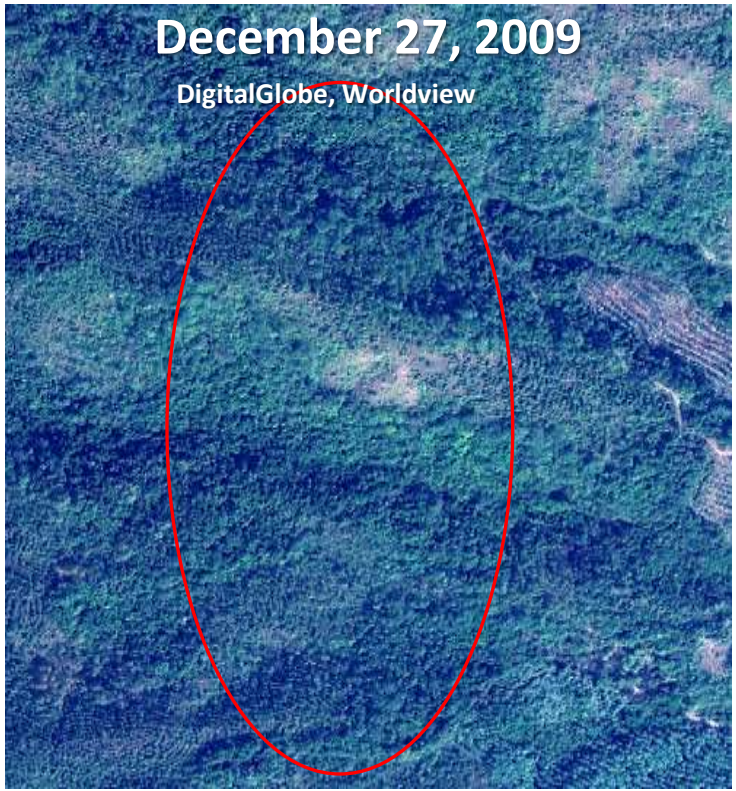
# Large Area Change Detection, Surveillance

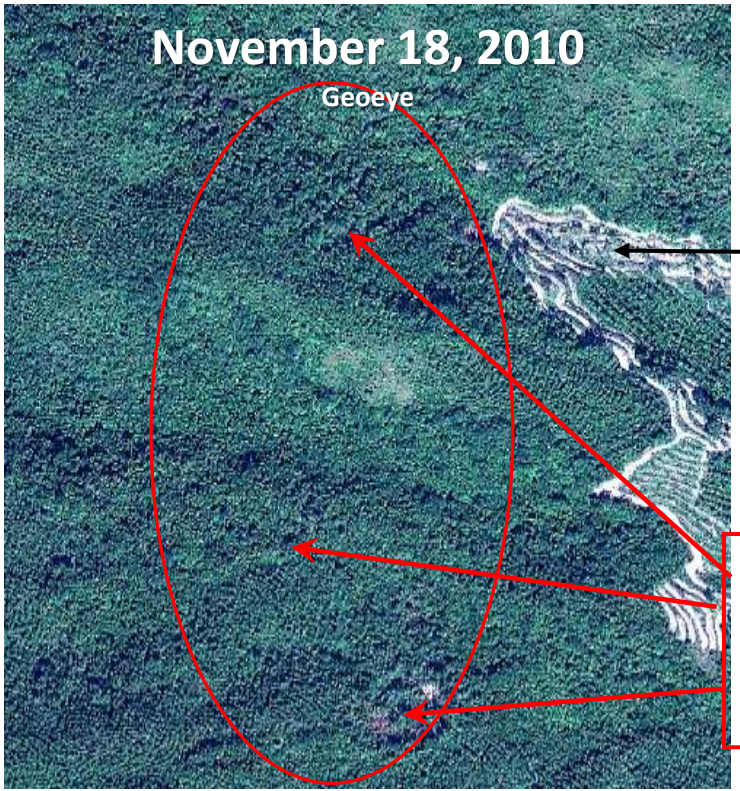
## Analogy between surveillance cameras and SAR imagery

- The problem of efficient, automatic use of optical images from space
- The opportunity for high resolution (better than 5 m) repeated SAR coverages
  - Identical illumination conditions
  - 100% reliability in obtaining the imagery

# The challenge of forest monitoring using optical imagery

## Hainan Island, China

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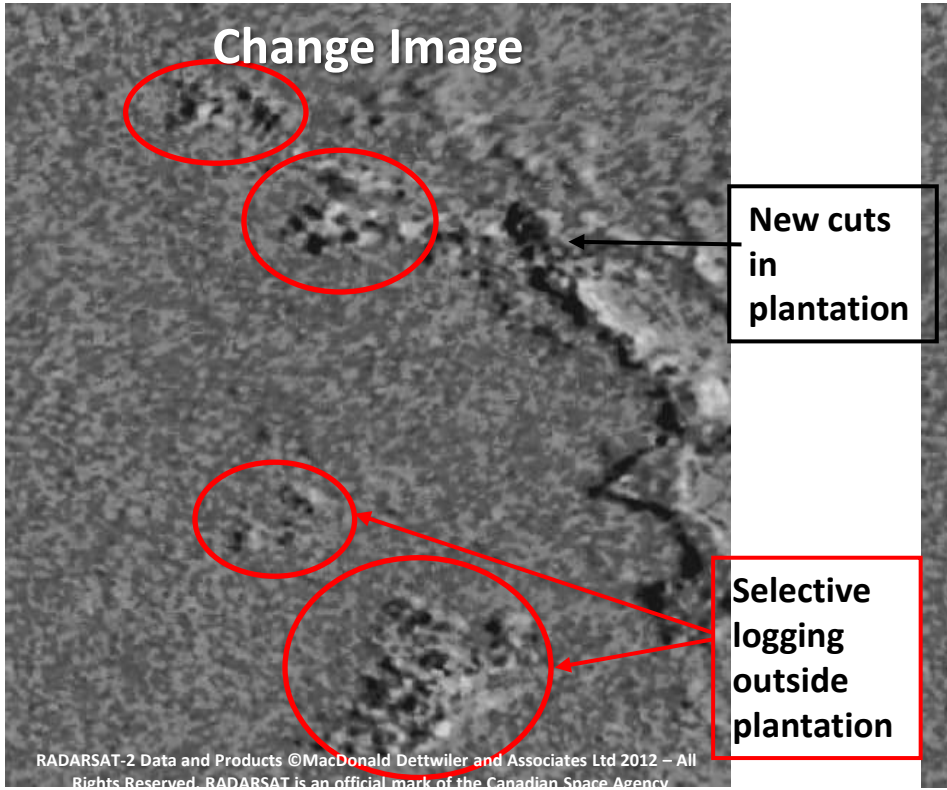
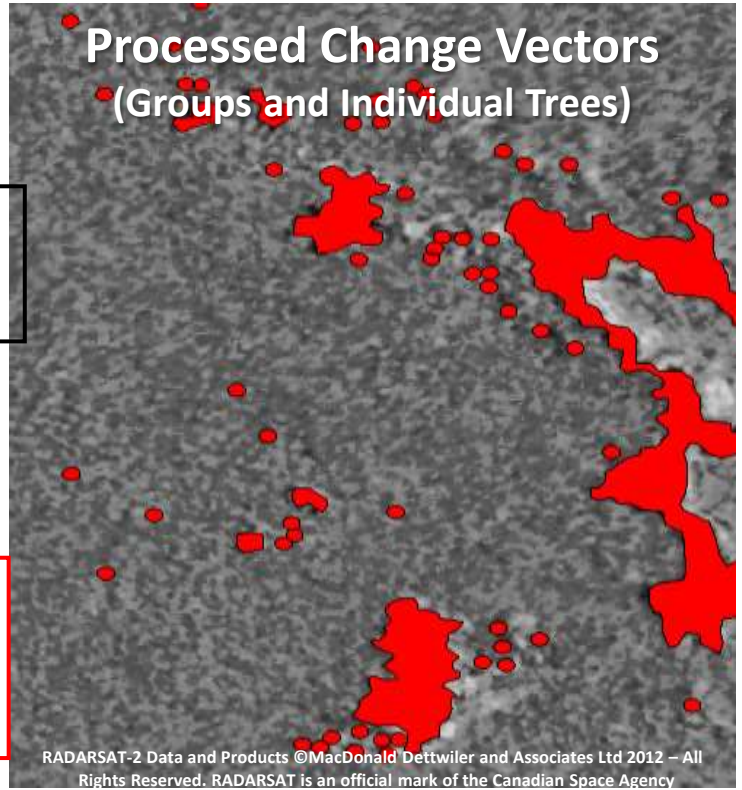
# RADARSAT: Automatic and effective forest monitoring

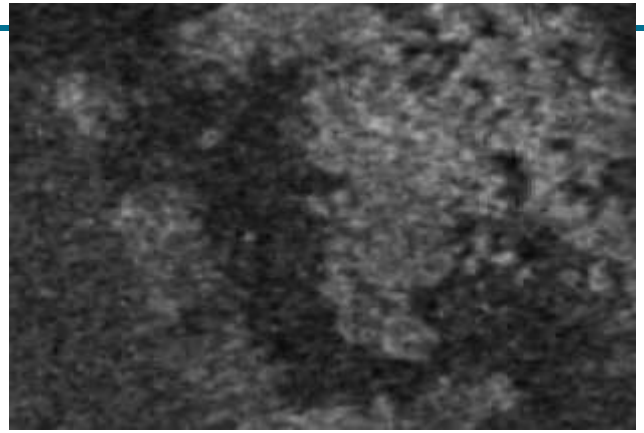
## (Hainan, China, December 26, 2009 – November 3, 2010)



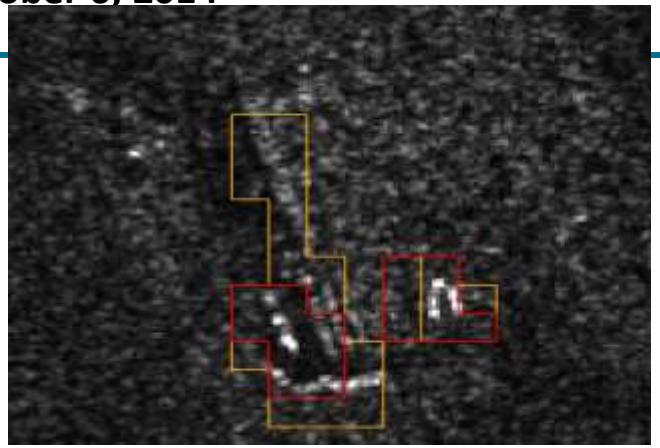
# Efficient Broad Area Surveillance for Defense Applications

## Where to look? WV imagery collected on October 6, 2014



RADARSAT-2

2014-10-01



WV-02, 2014-10-06

WV-02, 2014-08-08

# RADARSAT-2: “Tip and Cue”

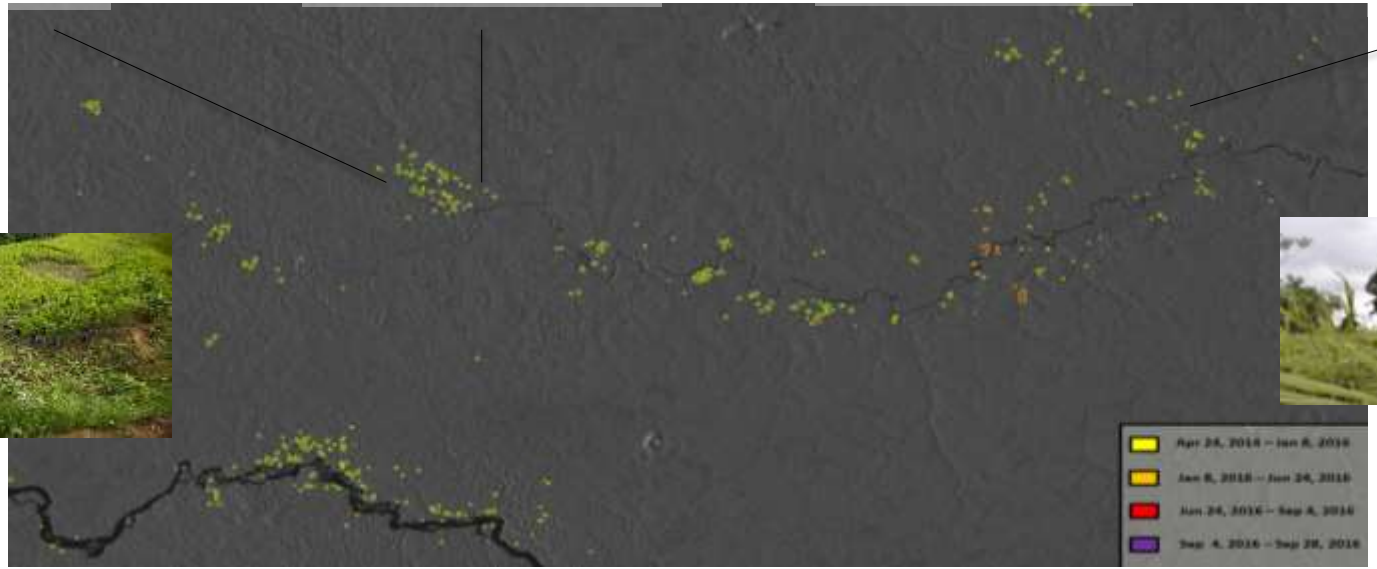
## For detailed analysis, inspection and enforcement

Illegal logging

Coca plantation activity

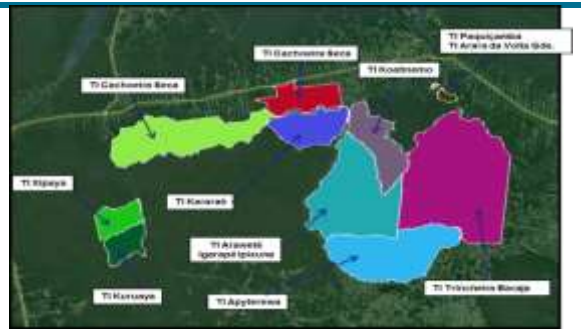
Illegal mining activity

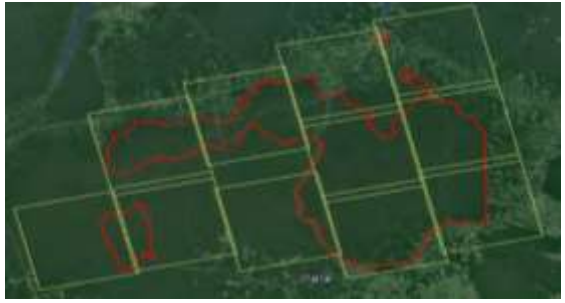
Illegal logging



# Brazil, Para Province, Xingu River Native Reserves

## RADARSAT-2 Monitoring program Funai (Fundação Nacional do Indio)

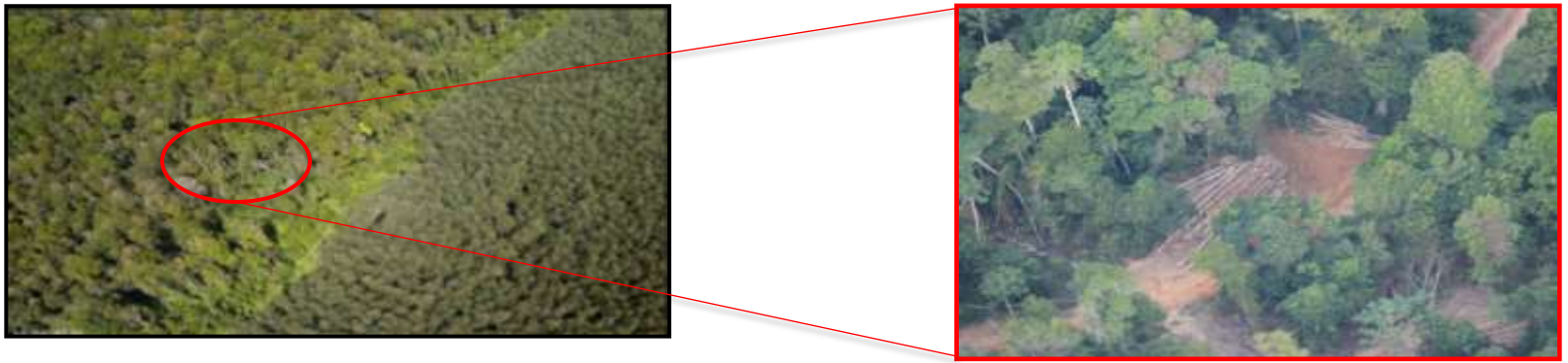




- Illegal logging and encroachment into native reserves related to dam construction and associated economic activity
- Full XF coverage every 24 days
- Forest alert products
- Started early 2016

# Indonesia (Sumatra, Kalimantan) Forest Concessions
# Zero-Deforestation enforcement of Conservation Forest
## RADARSAT-2 Forest Monitoring

- Program start October 2016
- 29 stacks (frames) repeated every 24 days
- First "Streaming" Forest alert service provided NRT (2 days after acquisition)

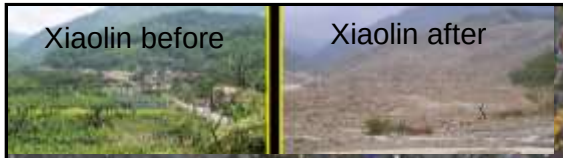


# Disaster Damage assessment

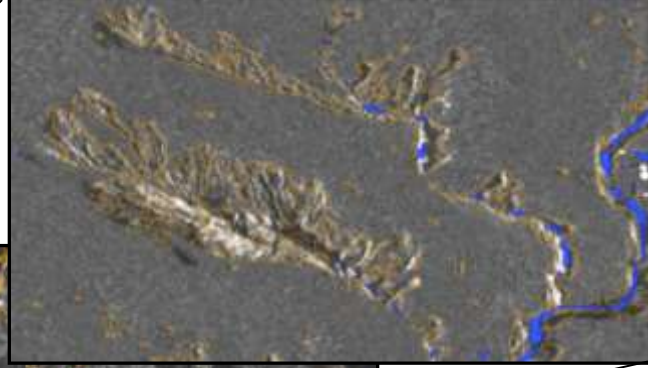
Typhoon Morakot, Taiwan, August 5 2009

Landslide inventory and hazards analysis

Using RADARSAT-2, 5 m (August 16,2009 vs. March 25, 2009)




Xiaolin

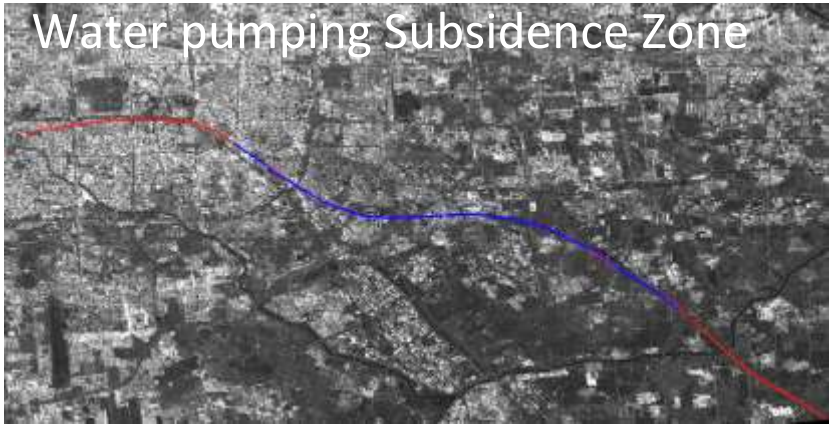


Unch. building
infrastructure
Damaged Bldg
infrastructure
Changed river
flooded areas
Landslides

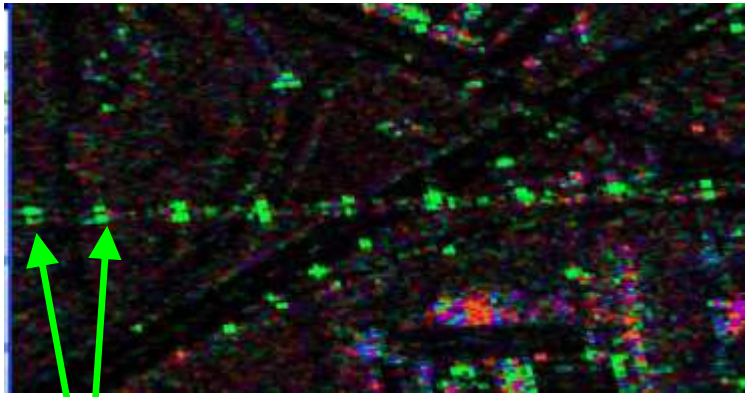
Unchanged,
low backscatte
Unchanged, ot

# InSAR deformation alerts: JingJin High Speed Rail (HSR)

## China (between Beijing and Tianjin)



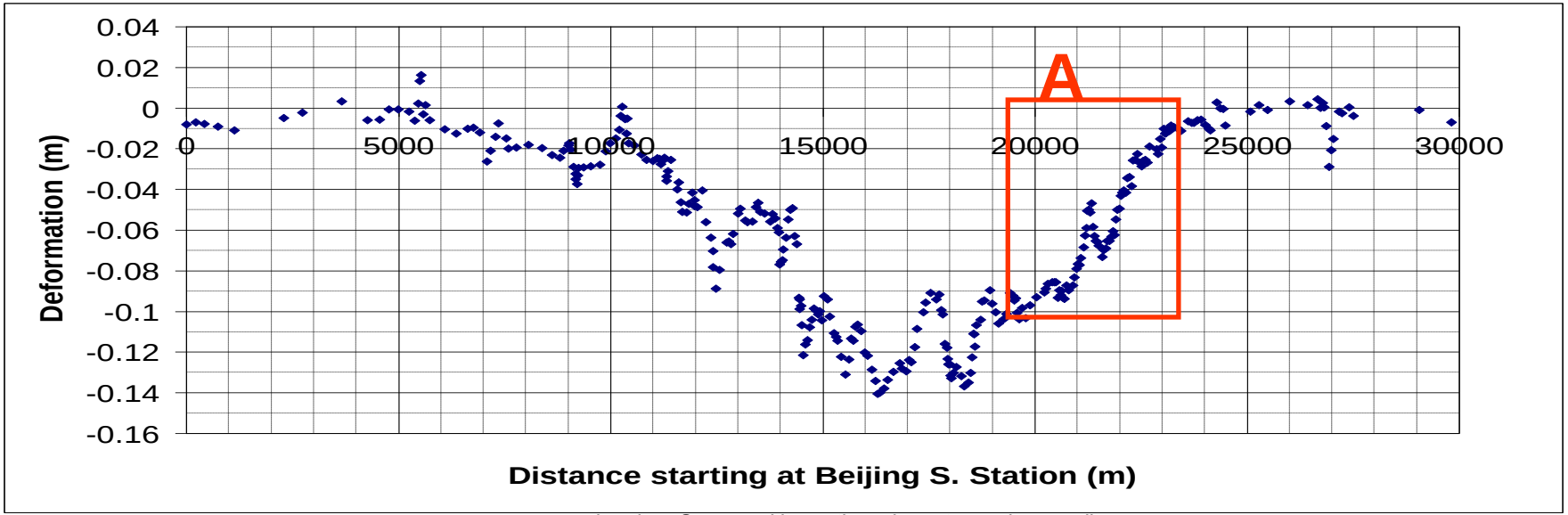

# Stable Reflections from the Rail Posts
## as visible in the SAR Imagery



Green: stable reflection in 5 scenes, usable for InSAR (CTM)

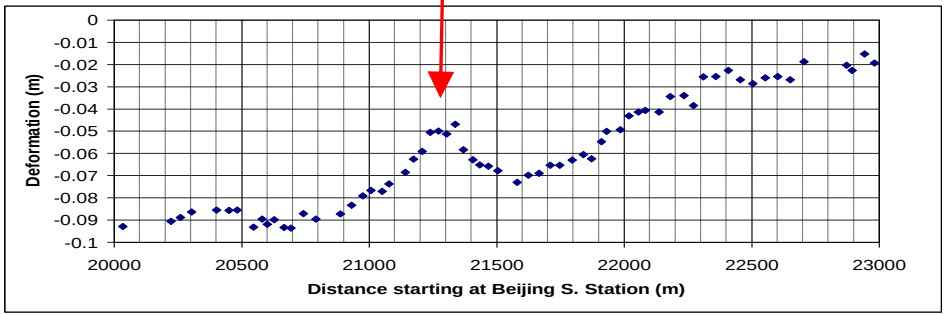
# Subsidence Profile Along HSR

## Maximum rates of approximately 10 cm per year



# Area A: Yizhuang Railway Station (at 21.3 km)
# Significant Deformation Signal (~5 cm)



# Conclusions

- Spaceborne SAR is an effective and efficient tool for land monitoring (sufficient resolution, swath width required).
- Opportunity for alert systems (e.g. in combination with EO imagery).
- Operational integration in user GIS environment