A Business Case for Archived SAR Data

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Content

- Large area land surveillance: High resolution AND wide swath
- RADARSAT-2 XF
- Archives of 5 m resolution R2
- Approach and examples of applications
  - Forest alert program: Tropical forest.
  - European border monitoring (alerts for troop build-up, refugee crisis)
  - Disaster damage assessment (e.g. Nepal)
  - InSAR
- Future use of Satellite SAR data for land applications
  - High resolution, wide swath
  - Satellites operated in same orbits for coordinated use of archive
  - More efficient, reliable, consistent and automatic contribution to earth observation
  - “Where to look”, combined use with high resolution optical imagery
RADARSAT-2 image modes

1. High resolution land
2. Large area land
3. Maritime

Wider swath + high resolution

Resolution (m)
Swath width (km)
Broad Area Land Surveillance
Analogy between surveillance cameras and high resolution SAR imagery

- Repeated identical geometry
- Identical illumination conditions
- 100% reliability in obtaining the imagery
- Automatic, efficient detection for large volumes of data

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Canopy Change Detection Steps

Before the Change

After the Change

Image 1
(before)

Image 2
(after)

Change image

Strong changes at very small scale due to canopy removal

Stable backscatter in forested areas

Change detection image

Alert! vectors

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Example of challenges of change interpretation of optical imagery
Hainan Island, China

December 27, 2009
DigitalGlobe, Worldview

Selective logging, difficult or impossible to detect

November 18, 2010
Geoeye

New cuts in plantation
RADARSAT-2 data processing algorithms automatically detect changes (Hainan, China, December 26, 2009 – November 3, 2010)

New cuts in plantation

Selective logging outside plantation
Detection capability: Infrastructure and Target Change Detection

- Detecting new reflections in context of existing reflections or existing activity from exact repeat SAR archive
- Applications e.g. construction, vehicle presence, trains
- Focus on automatic detection (alerts) not identification of targets
Alerts for newly detected “targets”

- Detecting new reflections in context of existing reflections or existing activity from exact repeat SAR archive
- Applications e.g. construction, vehicle presence, trains
- Focus on automatic detection (alerts) not identification of targets
Improved change detection using a SAR stack

- Exactly repeated observation geometry
- Identical well-known SAR illumination source
- Independent of weather and darkness
- Precise, reliable and efficient change detection
- Speckle noise of individual acquisitions can be filtered
RADARSAT-2  XF (Extra Fine)
Large images (125 x 135 km), High resolution (5 m)
Very dense information!

RADARSAT-2 XF March 5, 2015

XF-3, 20130613
Sample spacing: 2.66 m (sl.range) x 2.50 m (azimuth)
26784 samples x 54145 lines = 1.45 Billion pixels

<table>
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<th>Inc. Angle far edge</th>
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<th>Azimuth resolution (m)</th>
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Temporal density of exactly repeated RADARSAT-2 5 m resolution archives (since 2010)
Example of coverage in SE Asia
The benefit of exact repeat archive imagery

Detection of recent illegal logging roads in Para State, Brazil

photos from nearby illegal logging roads

6x10 km, change detection
MFW 20120207 - 20130625

Correlation of road network from R2 and IRS-P6

Single spotlight image acquired after the activity:
SLA5 20130929
Forest Logging Alerts... “where to look?”
Cachoeira Seca (Para, Brazil)
Validation Flights

Photos taken June 26, 2014

Alerts December 2013 – April 2014

Alerts March 2012 – December 2013

Flightlines, photos © ISA, 2014
“Logs on the ground”
Example of RADARSAT-2 Forest Monitoring Capability
High Resolution fire scar progression in Berbak National Park 2015
RADARSAT-2 vs. Landsat in Berbak NP
Frequency + reliability + detail = useful forensic insights
Middle East recent (since 2014) XF Archive coverage
(24 day repeat)
Humanitarian crisis in Kobane, Syria
Map based on Satellite imagery of November 7+9+13, 2014

RADARSAT-2 XF coverage
October 11 and November 4, 2014
In October 2014 Islamic State (ISIS) militants advanced to within a few miles of the Syrian-Kurdish City of Kobani, triggering a renewed stream of refugees seeking to cross the border into Turkey. The standoff for Kobani intensified every day with the influx of refugees arriving to the Turkish towns on the border – the majority of them being women, children, the elderly and disabled.
Kobani Refugee Overview
Kobani, Syria
DOI: Unknown SEN: GOOGLE EARTH GEO: 365329N/0382117E
DOP: 24 Nov 15

04 Nov 2014

Stable, Min Change (Yellow)
Growing, Sig Change (Red)
Reducing, Min Change (Green)
Growing, Sig Change (Red)

RADARSAT-2 Alert Polygon
Syria
Kobani
Turkey
Syria

Radarsat-2 imaging of the Nepal Earthquake of April 25, 2015

Image mode: XF-2 (excellent resolution for damage assessment)
- Size of image: 125 x 135 km, 26783 x 53929 pixels
- Pixel size: 2.66 x 2.49 m
- Nominal gr. resolution: 4.5 m
- Heading: descending
- Incidence angle: 31.6-38.7 degrees

Acquisition date and time:
- April 29, 2015 00:19:49 UT.

Archive imagery in exactly repeated geometry:
- April 5 2015, March 12, 2015, November 12 2014, October 19, 2014

Perpendicular baseline for the April 5 – April 29 2015 pair: 64.8 m
Radarsat-2 imaging of the Nepal Earthquake of April 25, 2015

Measurement of both Line of sight (middle) and horizontal motion (right)

Horizontal motion can be measured because of high resolution of source data
Radarsat-2 Land slide detection and building damage Assessment NW of Kathmandu (April 29, 2015)
Indication of damage to buildings, inspection using high res EO imagery (GE)

- Land slide detections
- High Building damage
- Medium Building damage
Discussion and Summary

- Significant technical opportunities for improved use of earth observation: high resolution SAR surveillance
  - Collection of large archives
  - Combined automatic use of archive and new imagery
  - Archive data mining
- Efficiency, consistency of change detection
- Satellites in same orbit imaging geometry. Coordinated use of archive.
- “Where to look”, combined use with high resolution optical imagery