Phragmites Mapping with SAR

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Outline

- Project Description
- Background
- Polarimetry and Compact Polarimetry
- SAR Data and Processing
- Preliminary Results
- Summary
- Future Work
Project Description

- Investigate polarimetric RADARSAT-2 Synthetic Aperture Radar (SAR) data to map the extent of *Phragmites* in the Georgian Bay Islands National Park, Ontario.

- Data is used for polarimetric analyses and to simulate compact polarimetry data in preparation for the RADARSAT Constellation Mission (RCM)

- Identify future R&D for RCM
Georgian Bay Islands National Park

Partners:
- Prabir Roy and Jean Poitevin, Parks Canada

Site:
- Georgian Bay National Islands Park
  - Beausoleil Island
**Background**

- *Phragmites australis* has become an invasive species in the Great Lakes region
- Largely due to changing climate conditions that expose large areas of fertile ground around wetlands
- Tall grassland species, native flora and fauna face significantly reduced habitats
SAR & Water Rational

- Dielectric Constant – major target parameter
  - Water ~ 70  Ice ~ 2-5  Air ~ 1
- RADAR – Water Seeker
- Standing Water – Specular
- “Bound” Water – in general backscatter magnitude increases as water increases while penetration depth decreases
SAR Surface Water Monitoring

Product Generation

Pre-Processing
- Radiometric
- Geometric
- Orthorectification

Product Generation

GIS Ready Output

Pre-Processing

• RCM Compact Polarimetry
• Other EO data

Pre-Processing

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Polarimetry provides...

\[ E^S = \frac{e^{jk_0r}}{r} \begin{pmatrix} S_{vv} & S_{vh} \\ S_{hv} & S_{hh} \end{pmatrix} E^i \]

Scattering matrix (complex)

3 Backscatter coefficients \( \sigma^\circ \)
- Amplitudes: \( S_{vv}, S_{hh}, S_{hv} \)

5 independent measures

2 Phases differences \( \Delta \phi \)
- \( \phi_{like} = \phi_{hh} - \phi_{vv} \)
- \( \phi_{cross} = \phi_{hh} - \phi_{hv} \)

\[ \sigma^\circ \cong \sigma^\circ_{ground} + \sigma^\circ_{vegetation - ground} + \sigma^\circ_{vegetation} \]
Freeman-Durden Decomposition

\[ |S_{HH}|^2 + |S_{HV}|^2 + |S_{VH}|^2 + |S_{VV}|^2 = \]

= Total Intensity
SAR and Flooded Vegetation

- Prototype techniques and approaches have been developed for the application of satellite SAR to the mapping of flooded vegetation.
- Flooded vegetation has dominant double bounce scattering.
- Polarimetric decomposition can be used to highlight flooded vegetation.

Images show changes in vegetation from April 27, 2010, to May 21, 2010, highlighting areas with double bounce scattering.
## SAR DATA

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2009 Results: Freeman-Durden Decomposition


Red = Double Bounce, Green = Volume, Blue = Rough Surface
2009 Results: $M$-$Chi$ Decomposition


Red = Double Bounce, Green = Volume, Blue = Rough Surface
2012 Results: Freeman-Durden Decomposition


Red = Double Bounce, Green = Volume, Blue = Rough Surface
2012 Results: *M-Chi* Decomposition


Red = Double Bounce, Green = Volume, Blue = Rough Surface
2013 Results: Freeman-Durden Decomposition

Jan. 09, 2013

Feb. 26, 2013

Red = Double Bounce, Green = Volume, Blue = Rough Surface
Spotlight and Fine Quad Imagery Comparison

June 8th, Fine Quad Image

June 9th, Spotlight Image

Smith Creek Watershed
Phragmites returns a strong double-bounce response in the summer imagery, but it cannot be separated from marsh or swamp using C-band.

To accurately map small patches of Phragmites high resolution imagery is needed.

Wetland classification and threshold values for Phragmites is still being established.

The phase in fully polarimetric SAR data helps with Phragmites classification.

Other researchers found winter to be useful for detecting Phragmites patches. May be due to the frequency of L-band.
Future Work

- RADARSAT-2 Fine-Quad and Spotlight data for another summer and winter season
- Investigate Spotlight data in the winter season
- Acquire ALOS imagery and work with Laura Bourgeau-Chavez to investigate L-band