Mapping Wetland Type and Seasonal Inundation using Synthetic Aperture Radar in the ABoVE Study Domain

Dorthea Vander Bilt, Michael Battaglia, Nancy French, Laura Bourgeau-Chavez, Shaniqwa Martin
Michigan Tech Research Institute (MTRI), Michigan Technological University

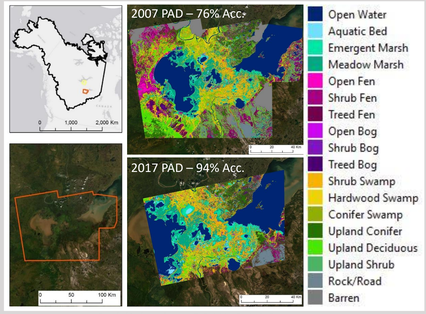
Motivation

Wetlands are an integral part of the boreal landscape; wetland type and hydrologic status are important for characterizing local to regional landscape ecology, biology, and surface hydrology, making accurate wetland mapping and characterization vital for purposes of carbon accounting and habitat assessment. The research we present shows the use of synthetic aperture radar (SAR) collections of the Peace-Athabascan Delta in Canada, to advance methods to characterize wetland type and hydrology. Methods that exploit the unique capability of SAR for mapping hydroperiod at multiple wavelengths is reviewed and discussed in this poster presentation.

Wetland Ecosystem Classification Maps

- Wetland type maps critical for waterfowl habitat (modified Enhanced Wetland Classification) created for 2 time periods to assess changes in habitat from c. 2007 to c. 2017
- Multi-season electro-optical and C- and L-band SAR data (Landsat + thermal, ERS2, PALSAR, Sentinel-2, PALSAR-2) were used as well as indices such as TPI and HAND

Peace Athabasca Delta (PAD)



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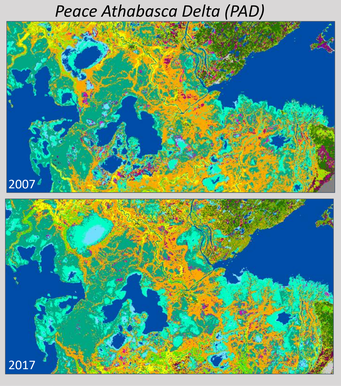
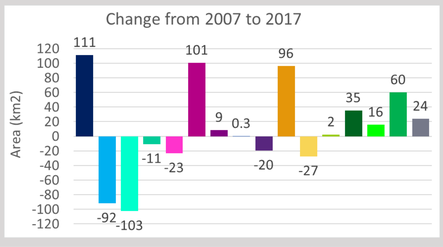


- The dominant cover types for 2007 & 2017 were water (36%, 32%), shrub swamp (16%, 14%), meadow marsh (14%, 13%) and emergent marsh (7%, 8%)



Field data collect August 2019 ground truthing wetland types and delineating inundation extents.

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SAR Frequency Utility for Inundation

Since different wavelengths provide varying vegetation structure and moisture information, utilizing multiple X-, C-, and L- band can act in a complementary fashion, especially for wetland type identification

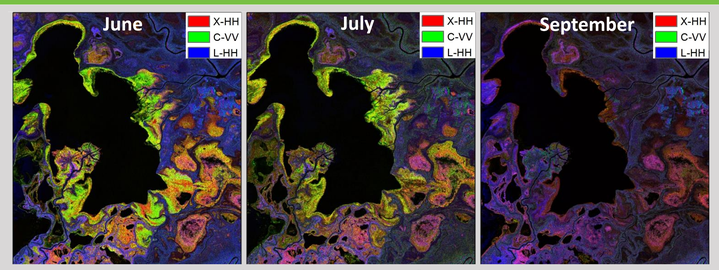
- L-Band ~24 cm Flooding beneath shrubs & trees
- C-Band ~5 cm Flooding in marshes & sparse shrubs
- X-Band ~3 cm Flooding in sparsely vegetated marsh

Shrub Swamp

Dense Emergent Marsh

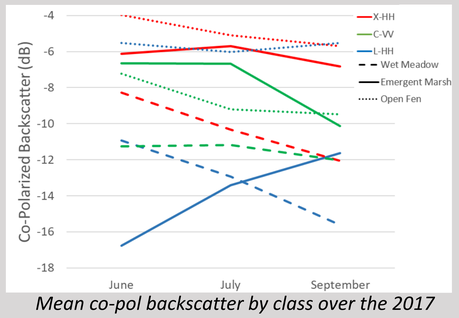
Sparse Emergent Marsh

Multi-Frequency Analysis



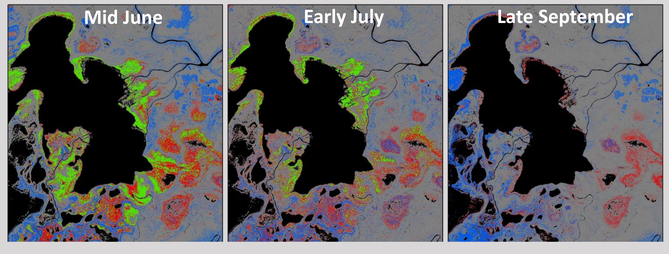
RGB composites showing co-polarized backscatter of X- (red), C- (green), and L- (blue) from three timeframes in 2017 PAD

- Wavelengths are sensitive to vegetation moisture conditions and flood state
- Backscatter decreases throughout the growing season due to decreases in moisture (L-band more perhaps sensitive to increased stem density)



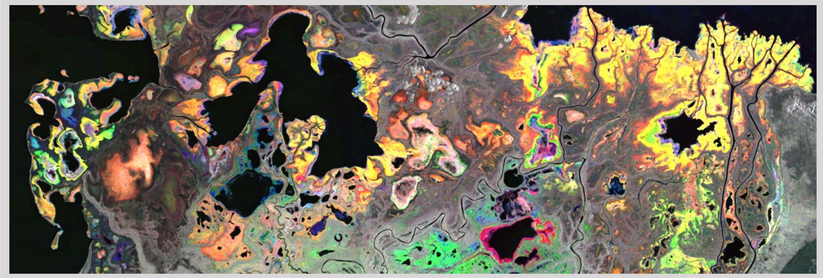
Mean co-pol backscatter by class over the 2017 growing season in the PAD

Flooded vegetation maps in the PAD for 3 time-frames for X- (red), C- (green), and L- (blue) band sensors



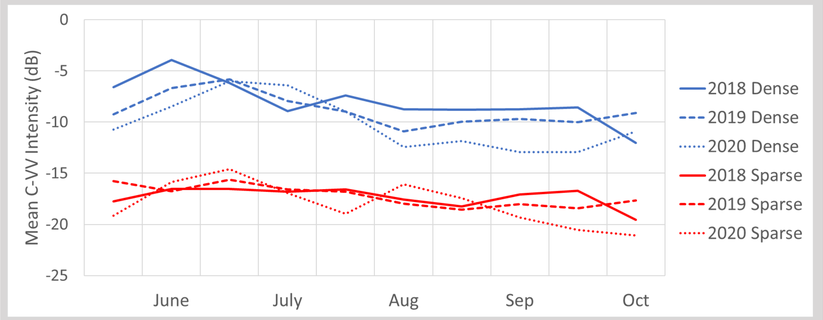
- When inundation algorithms are applied to different wavelengths, flooded vegetation extent is variable (Sentinel-1 IW mode VV is especially deficient in late season, when vegetation moisture is low)

C-band Inundation and Hydroperiod



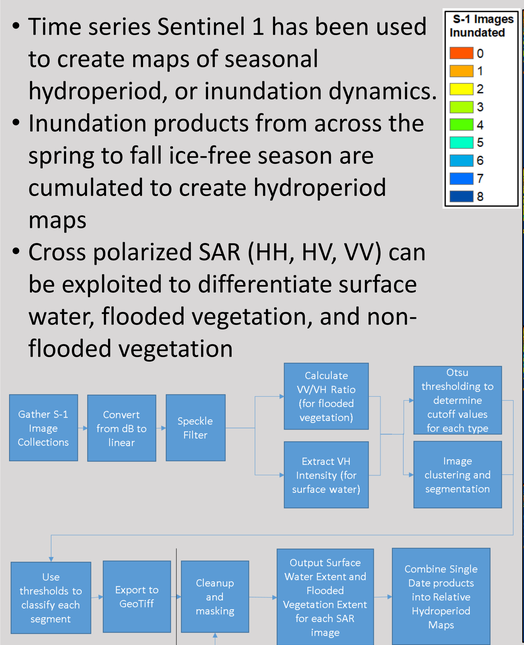
Mean C-VV backscatter for 2018 (red), 2019 (green), and 2020 (blue) from Sentinel-1 over the PAD

- RGB visualization of mean C-band Sentinel-1 VV backscatter from 2018-2020 shows significant interannual variability in flooded vegetation (bright colors)
- Backscatter increases early in the season as vegetation emerges, then decreases later as vegetation senesces and water content decreases

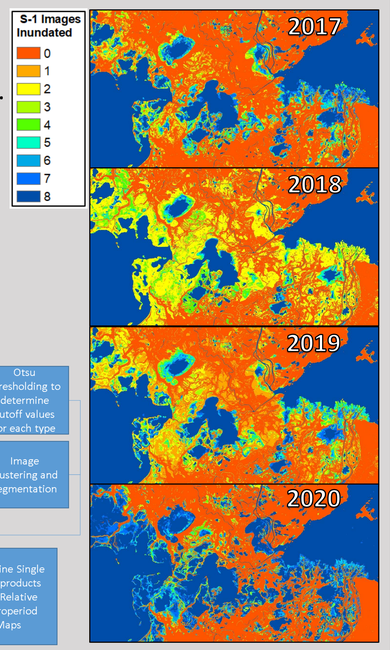


Time series of mean C-VV backscatter for 2018-2020 for dense and sparse samples of emergent marsh

- Time series Sentinel 1 has been used to create maps of seasonal hydroperiod, or inundation dynamics.
- Inundation products from across the spring to fall ice-free season are cumulated to create hydroperiod maps
- Cross polarized SAR (HH, HV, VV) can be exploited to differentiate surface water, flooded vegetation, and non-flooded vegetation



Workflow to calculate flooded vegetation and hydroperiod from Sentinel-1 C-Band multi-polarization SAR



Annual hydroperiod maps in the PAD calculated from cumulating the number of times each pixel is classified as inundated over the annual time series