Mapping Boreal Peatlands for Assessment of Vulnerability to Wildfire

Contact Information:
Laura Bourgeau-Chavez
lchavez@mtu.edu
734-913-6873

Laura L. Bourgeau-Chavez and Richard B. Powell
Michigan Tech Research Institute, Ann Arbor, Michigan
Eric S. Kasischke, Department of Geography, University of Maryland
Merritt Rae Turetsky and Brian Benscoter, University of Guelph, Ontario, Canada

ABSTRACT

Boreal peatlands comprise 25-30% of the global boreal forest region and are widely recognized as one of the largest terrestrial reservoirs for carbon in the Northern Hemisphere. Since boreal peatlands store tremendous reservoirs of carbon below ground, it is important to understand their vulnerability to wildfire as climate change lowers water tables and exposes C-rich peat to burning. One of the major uncertainties in more accurately assessing the role of boreal fires on atmospheric trace gas concentrations is our poor understanding of how fire influences more poorly drained ecosystems such as peatlands. To quantify carbon emissions from peatlands due to wildfire, we first need to have good maps of peatland types and understand the fire regime and burning characteristics of each type. Research presented here is the first step; mapping peatland types (bog, fen, marsh, and swamp) as well as level of biomass (open, wooded, forested). The method developed employs multiple dates of 2007 Synthetic Aperture Radar (SAR) and Landsat optical-IR remote sensing data within an object-based classification workflow which allows for mapping areas as small as 1 hectare with high overall accuracy. These maps are compared to an air photo-based (circa 1980s photos) interpretation for accuracy, but will also be compared to field data due to the time lag between the air-photo (1980s) and SAR-optical (SAR-EO 2007) maps.

DATA SOURCES

850,000 ha Study Area of Central Alberta

- August 2008 Landsat TM Bands 1-5, and 7
- July and August 2007 PALSAR L-HH, L-HV
- June and August 2006 ERS-2 C-VV

Pelican Lake Area Subsets

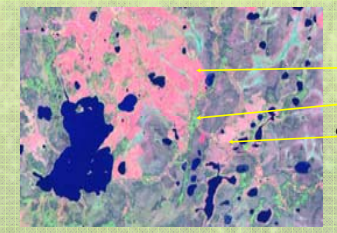
(See subset location on Resulting Peatland Map)

Open Fens (dark)
Upland Forest (white)
Bogs (pink-gray)
Swamps (red)

2007 PALSAR
July L-HV
August L-HV

Wooded Fens (cyan)

2007 PALSAR
July L-HH
August L-HH

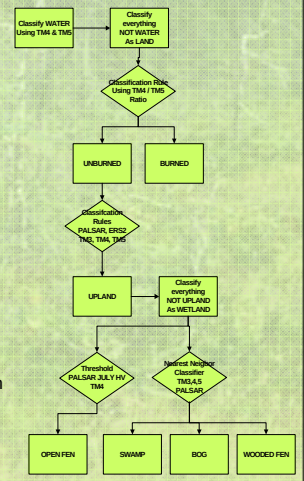


1998 Fire Scar (red)
Uplands (green)
Old Fire Scars (pink)

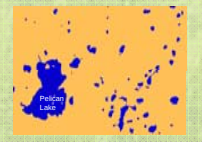
Landsat 5 TM
August 2008
Bands 7,4,3

TECHNIQUES

- Input data sources were segmented into digital image objects which capture homogeneous land cover types.
- Image objects were compared to reference data and classified with a top-down contextual hierarchical approach using decision tree rules and refined using nearest neighbor classification techniques.

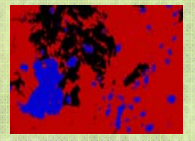


Process Tree Level 1



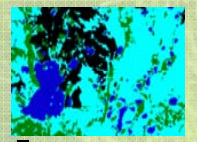
land
water

Process Tree Level 2



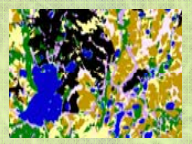
burn
unburn
water

Process Tree Level 3



burn
upland forest
wetland
water

Process Tree Level 4

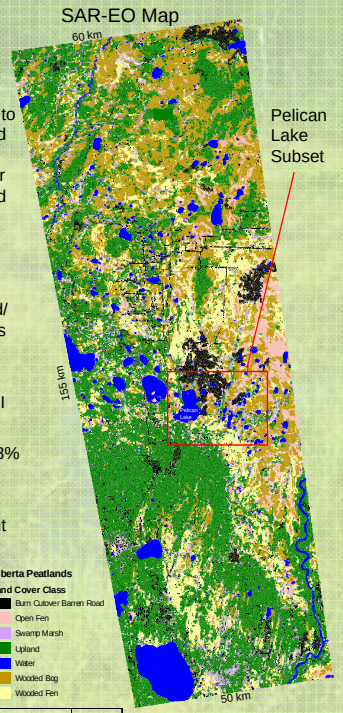


All thematic classes defined. See legend for full map, at right.

RESULTS

- Initial evaluation SAR-EO Map was compared to 1980's peatland type map created from air photos and field surveys.
- 85% overall agreement for broad scale Level I Wetland/ Upland classes
- 70% overall agreement for detailed Level II classes
- Fen 60% & 78% agreement
- Bog 72% & 62% agreement

SAR-EO Map



SAR-EO Map	Reference Map				Omission Errors
	Upland	Wetland	Water	Total	
Upland	964	218	5	996	79%
Wetland	260	1872	1	2133	87%
Water	0	0	172	172	87%
Total	1224	2090	175	3329	
Omission Errors	74%	90%	98%	Overall Agreement	82%

SAR-EO Map	Reference Map						Omission Errors
	Fen	Swamp Marsh	Upland	Water	Wooded Bog	Total	
Fen	752	60	172	3	232	1256	60%
Swamp Marsh	38	65	26	0	18	127	51%
Upland	71	57	784	0	84	996	79%
Water	3	3	0	172	0	178	97%
Wooded Bog	117	16	81	0	556	772	72%
Total	981	201	1064	175	891	3329	
Omission Errors	78%	27%	34%	98%	62%		Overall Agreement 70%

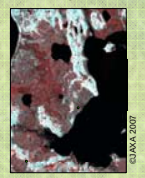
Location of the 850,000 hectare study area

DISCUSSION AND NEXT STEPS

- Generally bogs and fens are difficult to distinguish from each other, however using the multi-date, multi-band SAR allows for distinction in moisture and levels of biomass. This allows a clearer distinction of these two peatland types with improved accuracy over Landsat data alone.
- A comparison of the SAR-EO map to the circa 1980's map showed moderately good agreement for bogs versus fens, but there is confusion between the two with this reference map. **A big question is: Which method is more accurate, Air Photo interpretation or SAR-EO fusion, for distinguishing bogs from fens?** More recent field observations are needed to accurately assess this question.
  - A visual analysis of the Landsat, SAR, 1980's air photo map, and the results of this study reveal differences and inconsistencies due to the age and scale of the reference data, changes in the landscape, the scale of the image objects used for classification, and differences in spectral signatures.

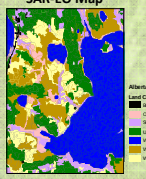
Landsat (4,3,2)

PALSAR



Air Photo Map Overlaid on Landsat

SAR-EO Map



- Additional fieldwork will be conducted in 2010 to further refine the classification algorithm and better assess the SAR-EO map product.

Research funded by NASA grant NNX09AM15G