A Lidar/Data Fusion Classification of Heterogeneous Land Cover Types in Alberta and NWT

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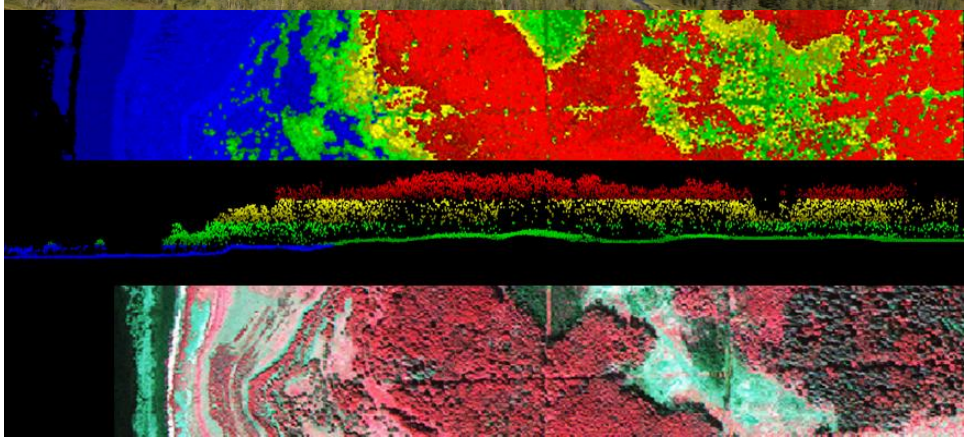
Problem Statement:

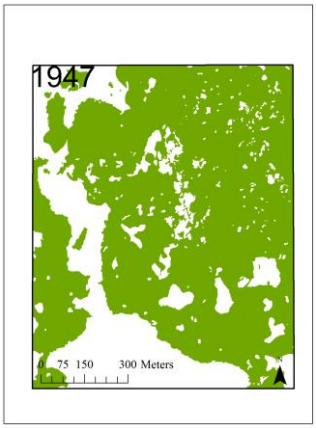
Accurate classification of rapidly changing land covers is fundamentally important for quantifying how changes affect ecosystems… (assumption of accuracy…).

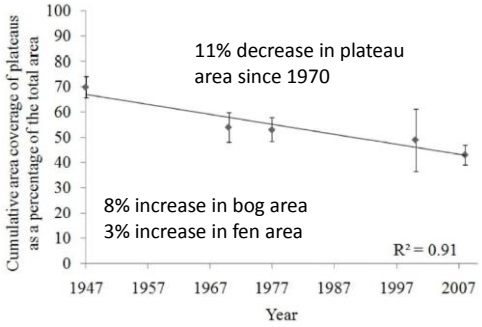
Also important for modelling earth-system processes.

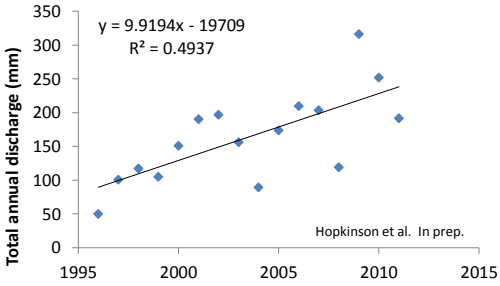


Far Reaching Implications…

Historical Land cover change due to permafrost thaw in NWT

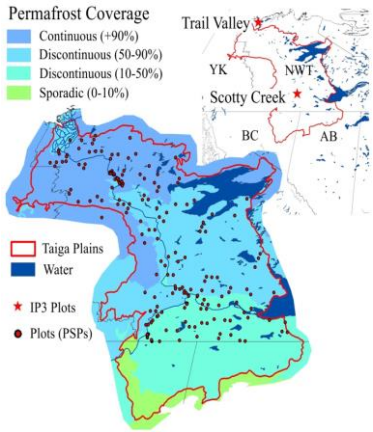




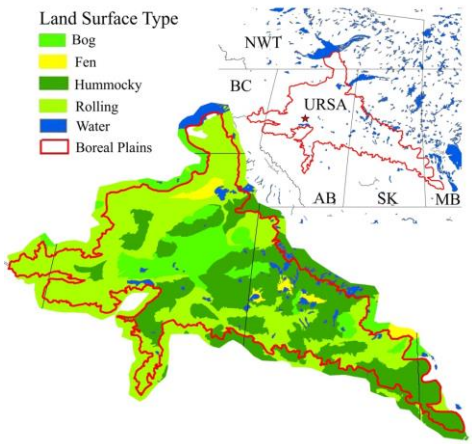


Two Sites:

Scotty Creek, NWT – Rapidly changing discontinuous permafrost



Utikuma Regional Study Area (URSA), AB – Heterogeneous upland/peatland complex



Fusion of Airborne LiDAR and WorldView 2 Spectral Data

Problem Statement:

Accurate classification is fundamentally important for quantifying how changes affect ecosystems

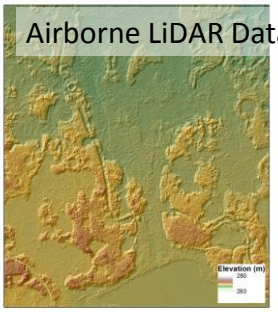
WHY??

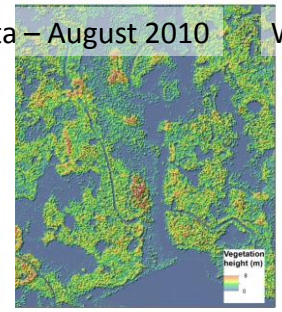
Accurate Change Detection	Improve Accuracy of Land Surface Models	Quantify Human Disturbance	Policy and Planning
- LC critical to accuracy of rates of change - Digitizing not fun! - Confusion matrices do not provide 'accuracy' . . .	- Increased errors due to inaccuracy of inputs - LSMs used as inputs to GCMs →prediction of future GHGs varies… . . .	- Linear features, reclamation monitoring… . . .	- Govt NWT, GoA, etc. wetland monitoring - Water resources planning - GHG contribution . . .

Without an accurate land cover classification, large uncertainties exist…

Objectives:

1. Develop decision-tree data fusion (DT) classification method, compare with 'best' (spectral) supervised classification.





2. Validate the classification using GPS, water line, and manually delineated land cover types.

3. Application – ET Modelling; Runoff Modelling

Designing a Decision-Tree Fusion Classification

Airborne LiDAR Data | WorldView2

Topographic position | Texture | Vegetation structure | Single intensity | SVIs | Speckle

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Airborne LiDAR Data | WorldView2

Topographic position | Texture | Vegetation structure | Single intensity | SVIs | Speckle

LiDAR DEM
- IDW grid
- 10 m search radius
- Low-pass filter (3 x 3)

(removes surface het.)

Designing a Decision-Tree Fusion Classification

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- IDW grid
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(removes surface het.)

→ Focal statistics

- Iterative 10 to 100 pix circular search

Correspondence w measured?

Yes? ↓ Is Best? Yes → No

No? → toss

Designing a Decision-Tree Fusion Classification

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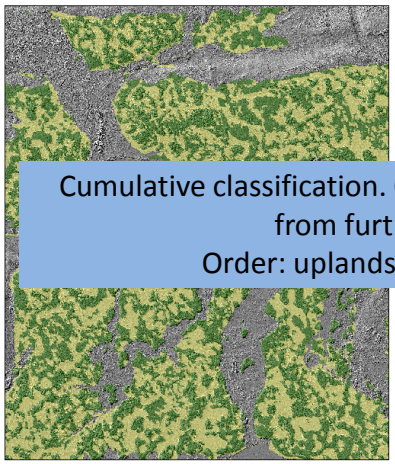

LiDAR DEM
- IDW grid
- 10 m search radius

Cumulative classification. Once classified, land cover removed from further classifications…
Order: uplands, water, plateau, bog, fen

Correspondence w measured?

Yes? ↓ Is Best? Yes → No

No? → toss

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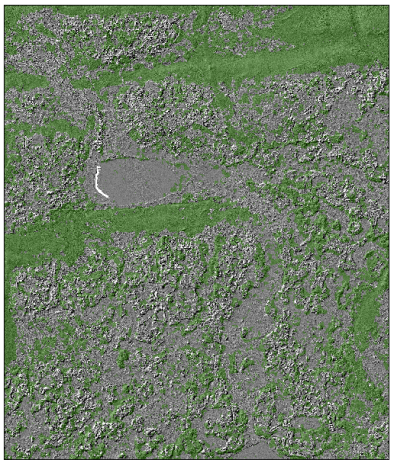


LiDAR DEM
- IDW grid
- 10 m search radius
- Low-pass filter (3 x 3)

(removes surface het.)
- Plan curvature (horizontal

rate of change of terrain aspect)

Correspondence with measured?

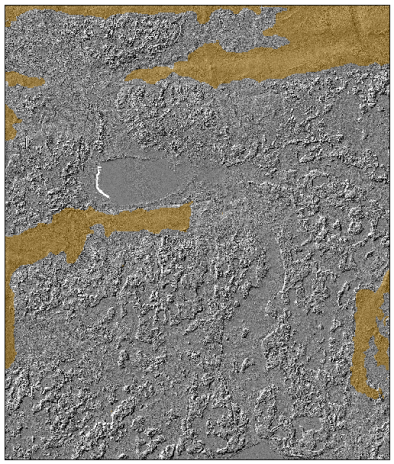
Yes? ↓ Is Best? Yes → No

No? → toss

Designing a Decision-Tree Fusion Classification

Airborne LiDAR Data | WorldView2

Topographic position | Texture | Vegetation structure | Single intensity | SVIs | Speckle



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Designing a Decision-Tree Fusion Classification

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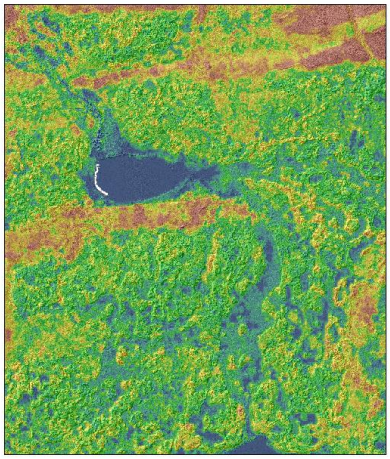


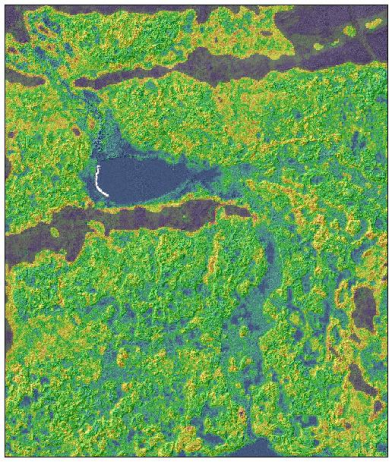
LiDAR DSM – DEM = CHM
- Max height
- 10 m search radius

(removes gaps)
- Iterative low-pass filter (mean)

Designing a Decision-Tree Fusion Classification

Airborne LiDAR Data | WorldView2

Topographic position | Texture | **Vegetation structure** | Single intensity | SVIs | Speckle



LiDAR DSM – DEM = CHM
- Max height
- 10 m search radius

(removes gaps)
- Iterative low-pass filter (mean)
- Iterative tree height range (1m Δz)

Yes? → Is Best? Yes → No

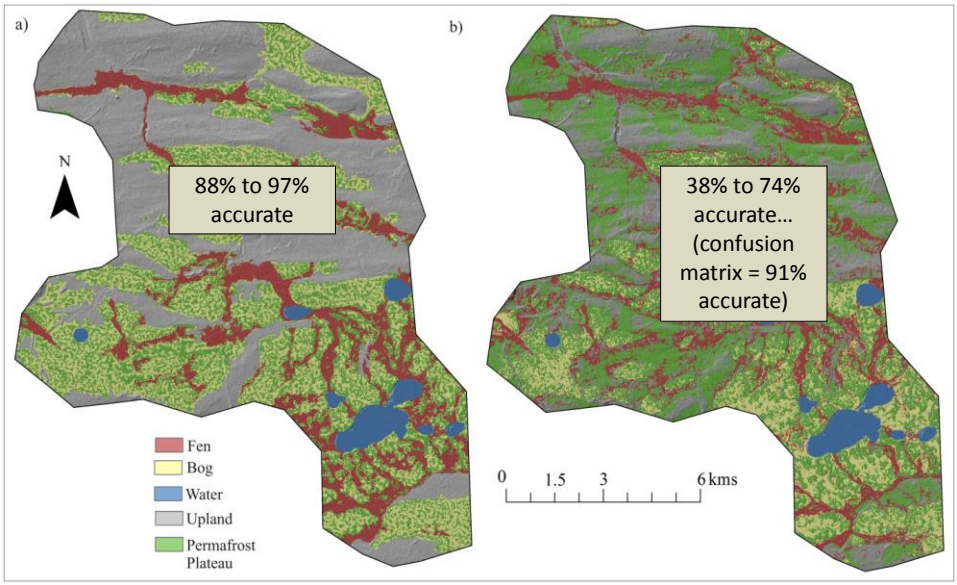
No? → toss

Upland = TP + Tex + Veg…

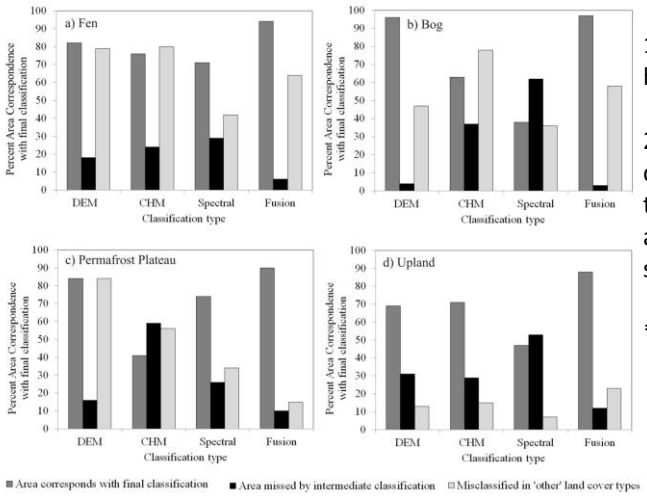
Land Cover Classification Comparison: Scotty

Accurate: WorldView2 and LiDAR fusion

Not so accurate: Worldview2 parallelepiped



How Well Did Individual Decision Criteria Work?



1. Fusion classification best.

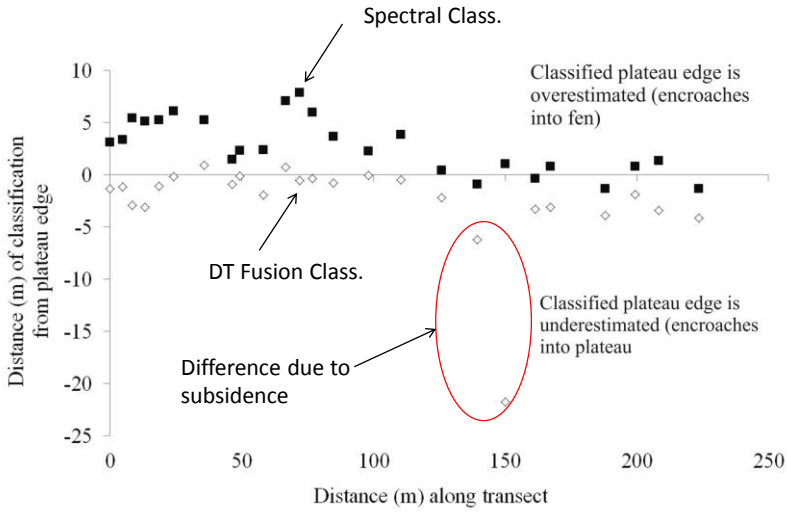
2. 82% - 96% of land covers classified using topographic derivatives alone (41% - 76% using veg structure, less for SVIs).

* Results for watershed

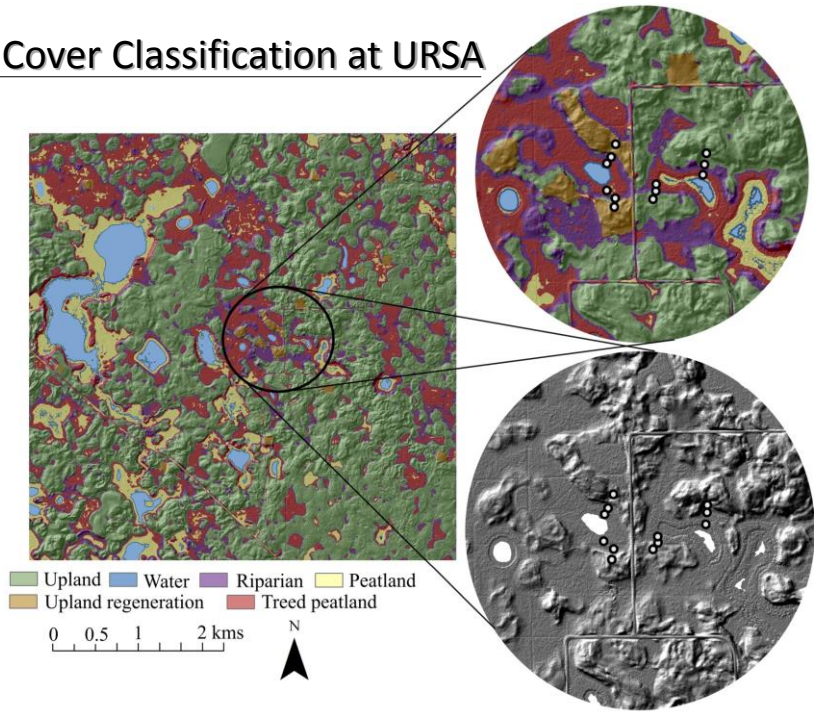
Comparisons with GPS Along Plateau/Fen Edge

DT Fusion classification: within 2 m, 60% of time

Spectral classification: within 2 m, 40% of time



Land Cover Classification at URSA



Area Coverage of Land Cover Types - Implications

Scotty Creek Discharge:

Land Cover	Fusion	Parallele-piped
Plateau	20%	43%
Fen	12%	18%
Bog	19%	12%
Upland	48%	25%
Water	2%	3%

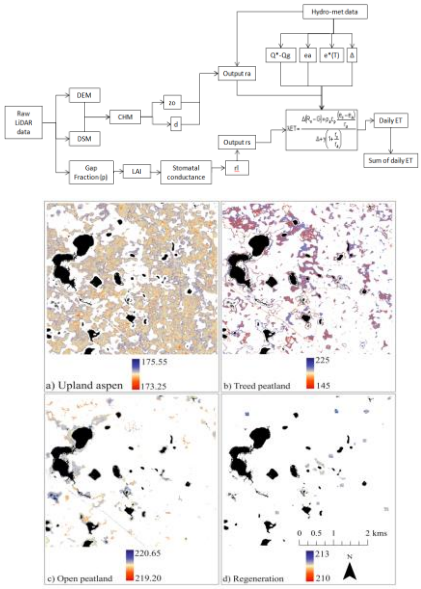
Differences of up to 23%

→ Significant implications to land surface modelling….For example:

Discharge significantly influenced by area.

Deviation in modelled discharge increases by 25% of difference in plateau area.

URSA Evapotranspiration, Scaling:



The Importance of a good land cover classification?

Scotty Creek Discontinuous Permafrost:

Spectral classification: ~2x greater plateau area than DT Fusion

→ SC = overestimate thaw-related discharge from plateaus

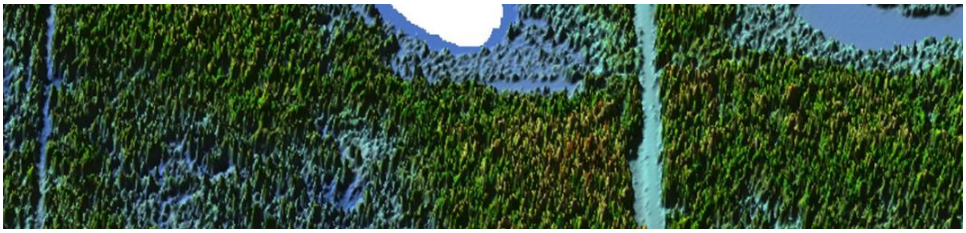
→ Suggests that increases in modelled discharge due to plateau thaw may be lower than previously anticipated…

URSA Western Boreal Plain:

→ Classification accuracy impacts ET model application.

→ May be used to monitor reclamation sites, disturbance areas, regeneration, etc.

→ Need to validate with (existing) transect, LAI, land cover spatial data.



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Dr. Aaron Berg (U. of Guelph)
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Tristan Goulden (Dalhousie U.)

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