

Wetland Mapping and Change Analysis in Canada Using Advanced AI and Remote Sensing Techniques

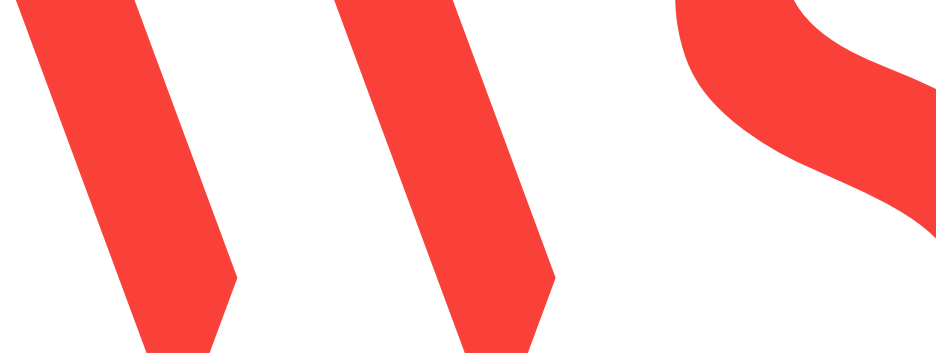
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The 8th ISDE International Lectures



Agenda

- Introduction
 - Wetlands
 - Remote Sensing
- Study Area and Datasets
- Methodologies
- Results Examples

Wetlands Services

- Flood control
- Erosion control
- Water purification
- Shoreline protection
- Soil and water conservation
- Carbon storage
- Recreation and tourist activities



Kidneys of Environment

Remote Sensing

Measurement of object properties from some platforms like:



Handheld device



Ground-based



Survey vehicle



Helicopter



Drone



Airplane



Satellite

Wetland Classification Methods

Traditional (e.g., field work)

- Expensive
- Time-consuming
- Not practical for large areas
- No practical for wetland change detection and monitoring
- Accessibility issues
- **Necessary for remote sensing methods**



Remote Sensing

- Cost effective
- Real-time data
- Large coverage
- Repetitive observation
- No limitation regarding the accessibility



Wetlands in Canada

- Canadian Wetland Classification System (CWCS)
- It was estimated that ~13% of Canada is covered by wetlands (Royal Canadian Geographical Society, 2012)
- Over the last decades, human activities and climate change have posed a serious threat to wetlands in Canada
- It's highly required to map and monitor wetlands changes in Canada

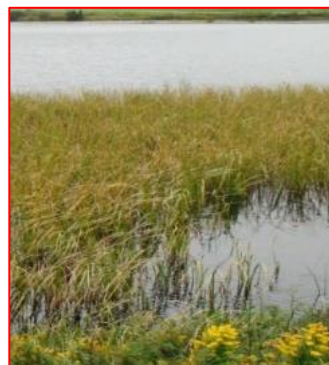
Bog



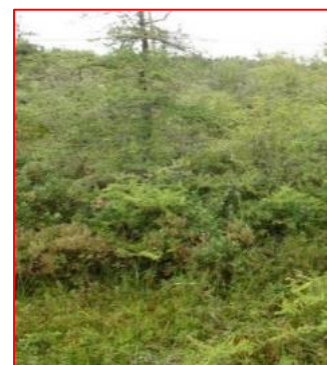
Fen



Marsh



Swamp

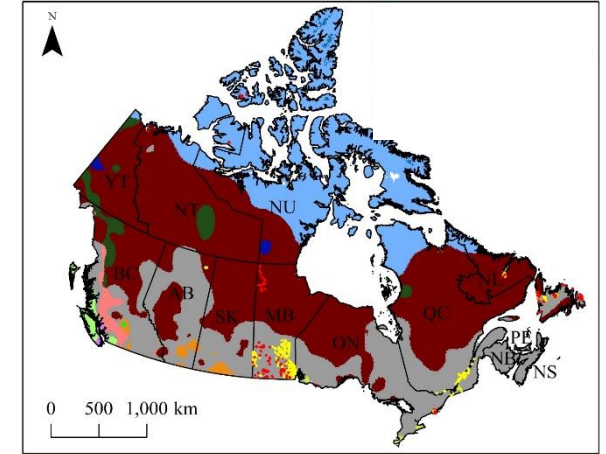


Shallow Water



Study Area and Datasets

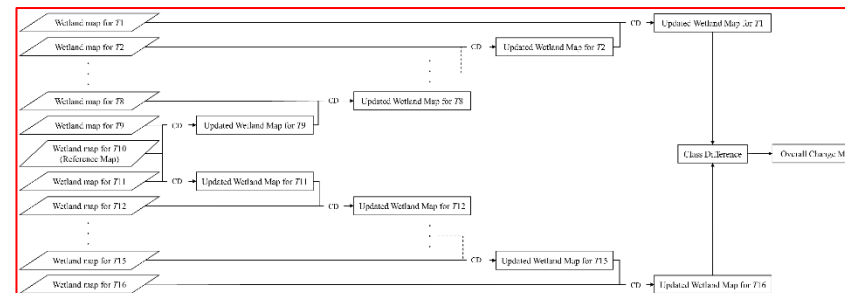
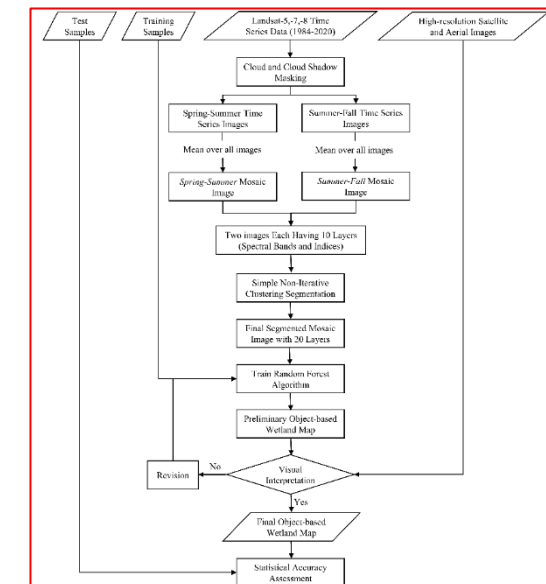
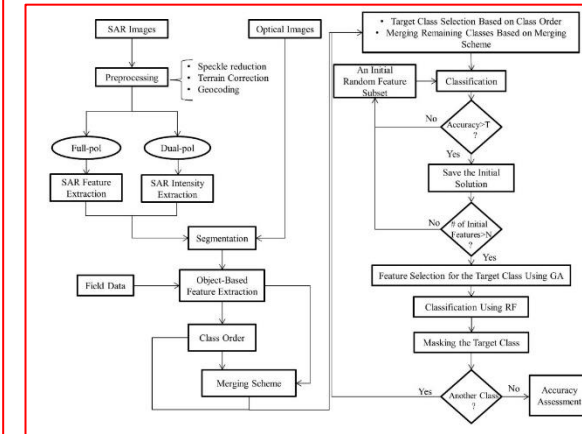
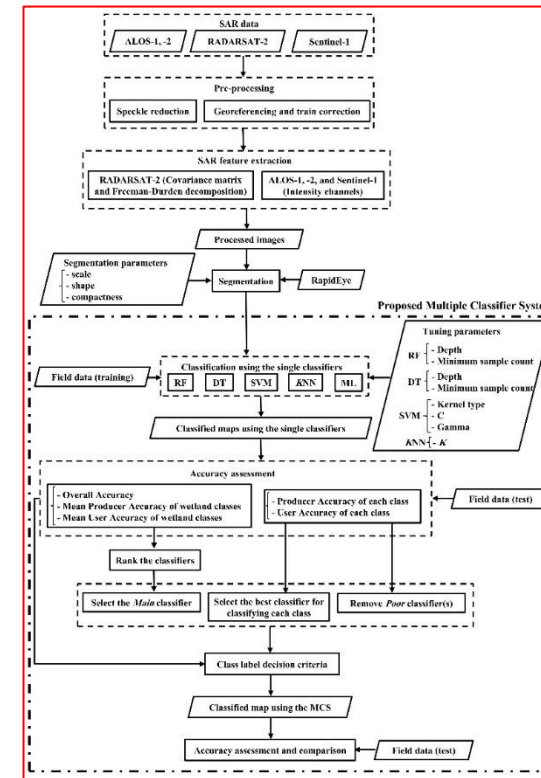
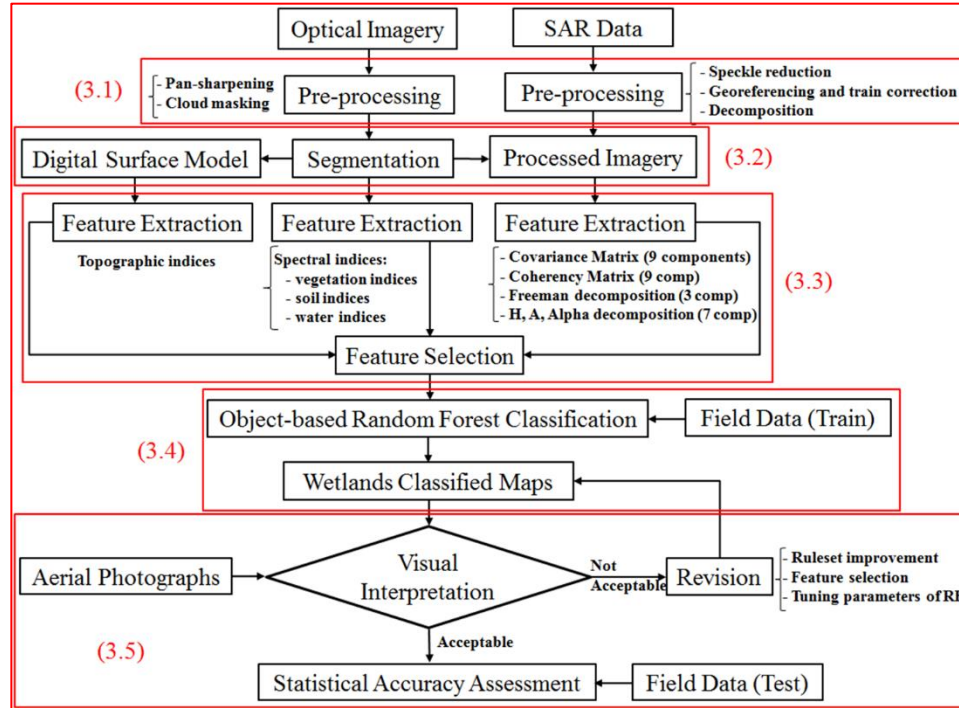
- In-situ data
 - GPS points of the locations of different wetlands
 - Drone high resolution imagery
 - 50% for training and 50% for validation
- Remote sensing data
 - Optical satellites: Worldview-2, RapidEye, Landsat-8/9, Sentinel-2
 - Radar: Sentinel-1, Radarsat-1/2, ALOS-1/2, TerraSAR-X
 - DEM data



Methodologies

More than 30 publications:

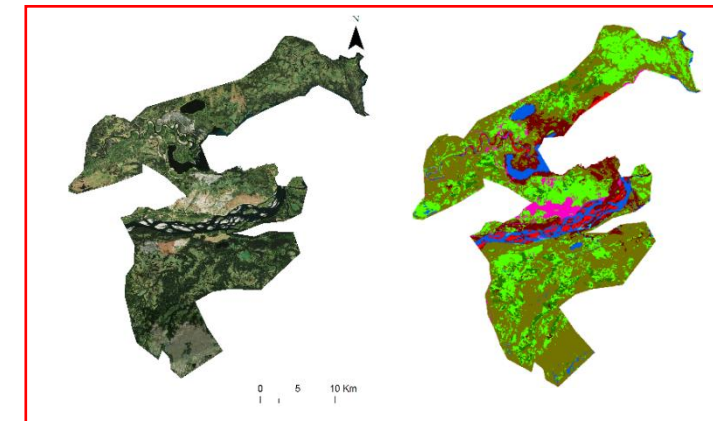
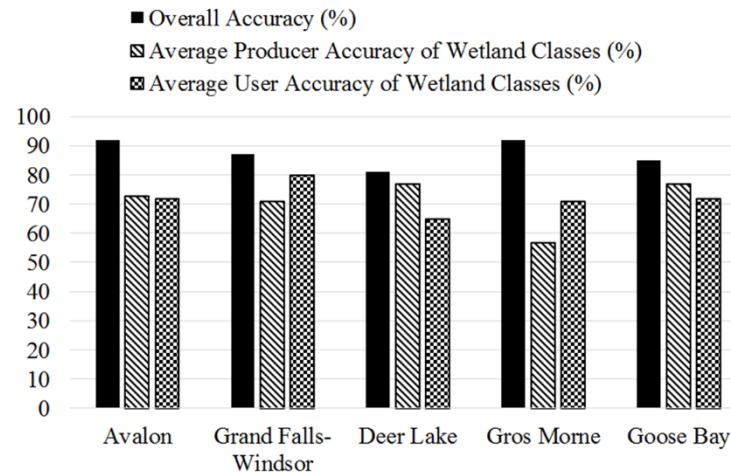
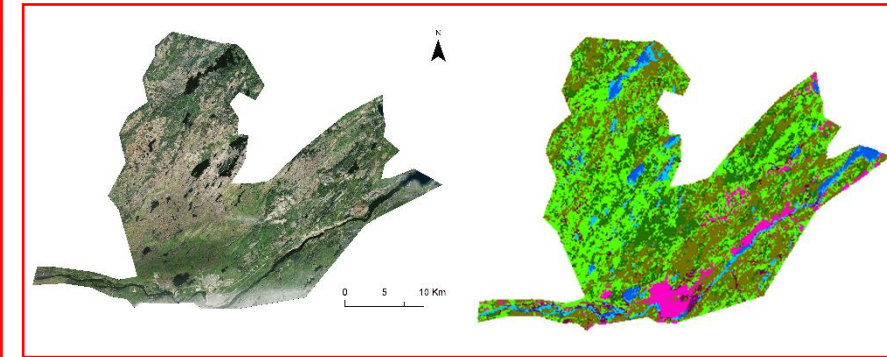
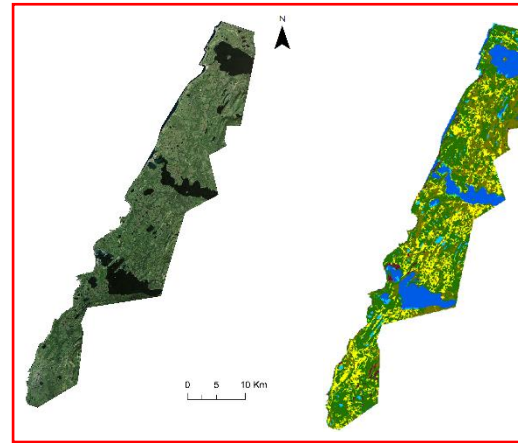
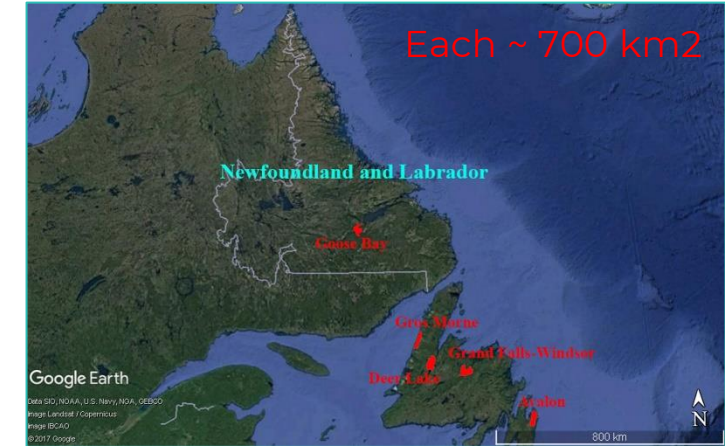
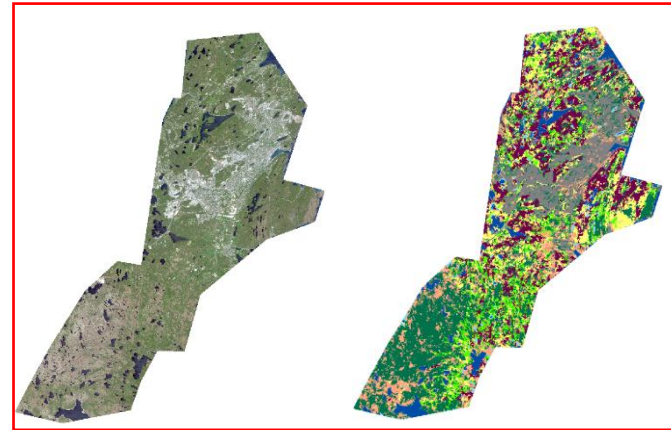
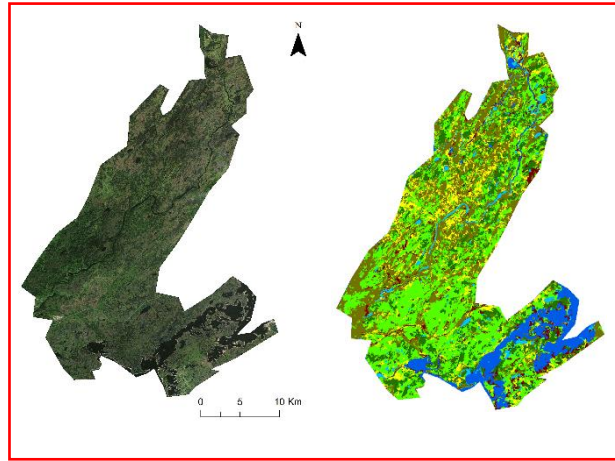
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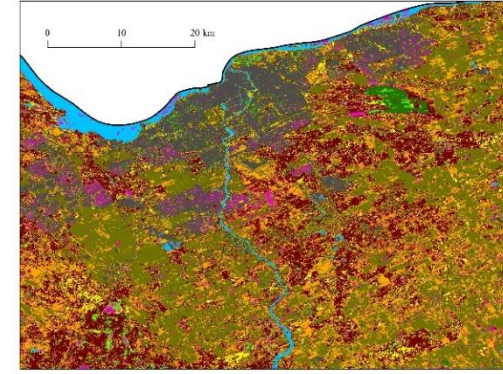
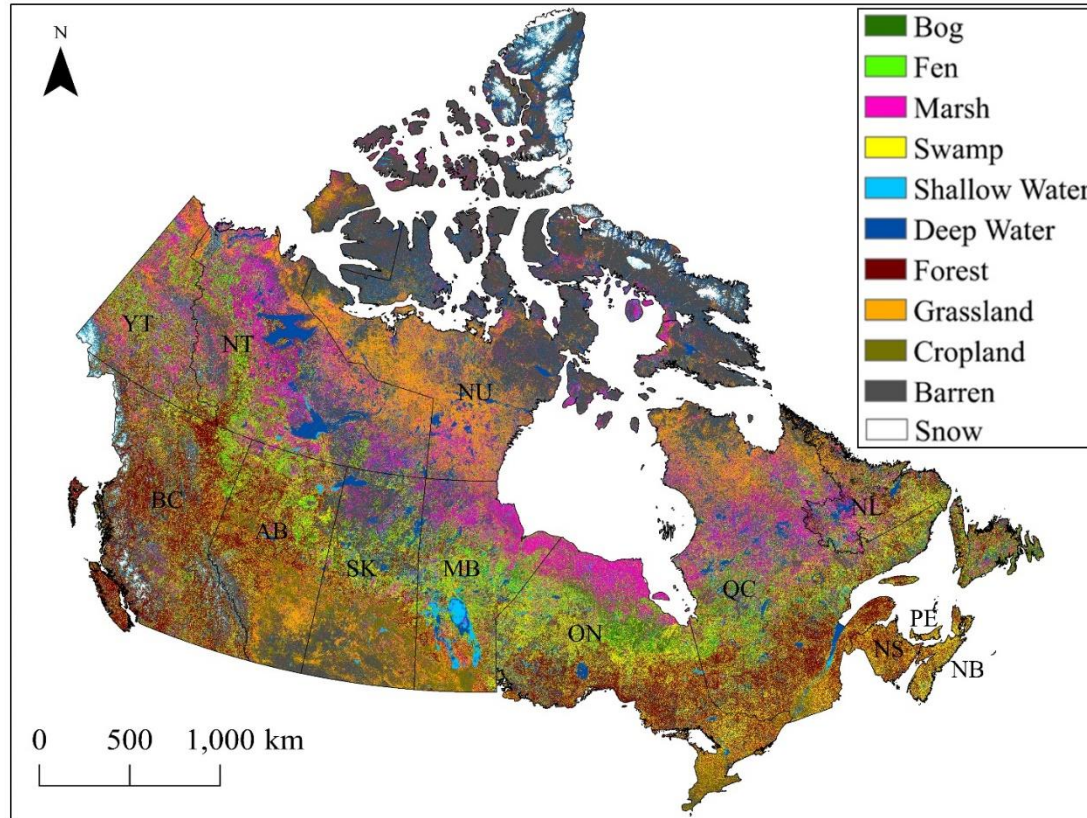
Methodologies

- Best results: a combination of optical, radar, and DEM data
- Pixel-based vs. **object-based image analysis**
- AI models: Random Forest classification algorithm
- Single-date vs. **multi-temporal datasets**
- Up to 90% overall classification accuracy
- Employing cloud platforms like GEE

Results Examples: Wetland Classification in Newfoundland



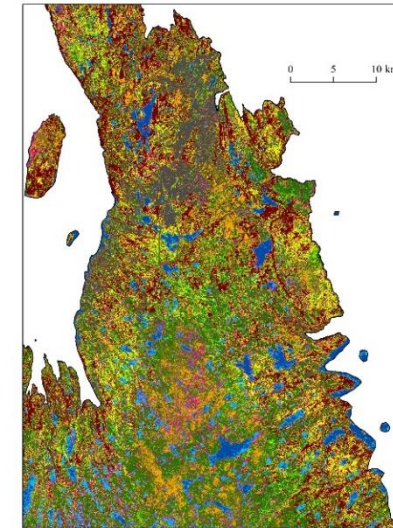
Results Examples: First Canada-Wide Wetland Map



(c)



(d)

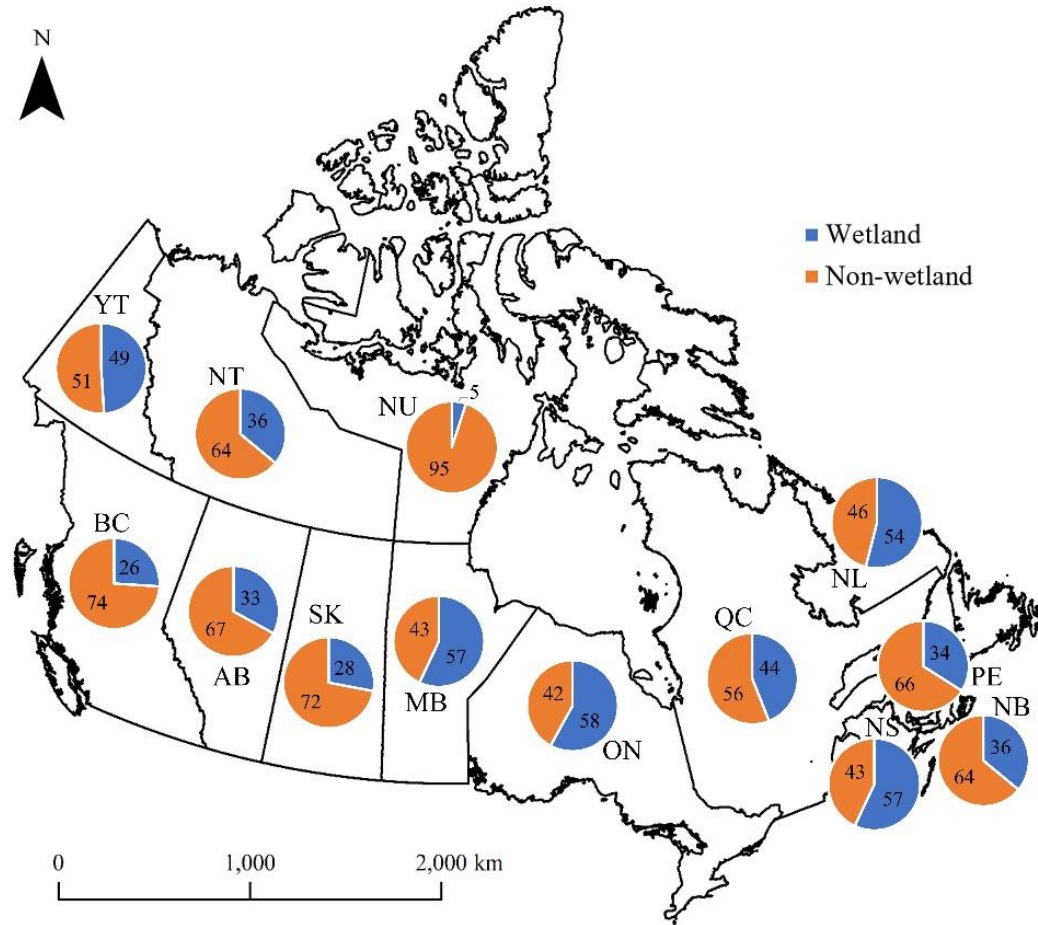


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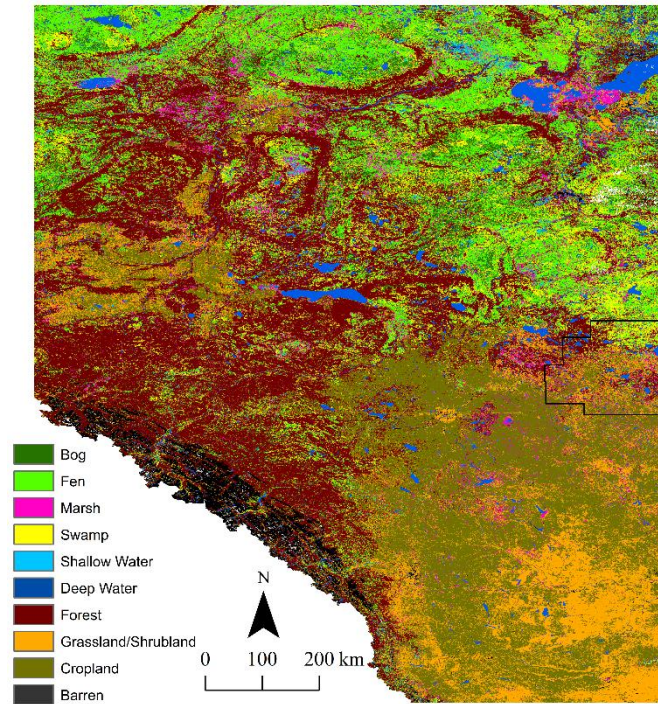
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Results Examples: First Canada-Wide Wetland Map

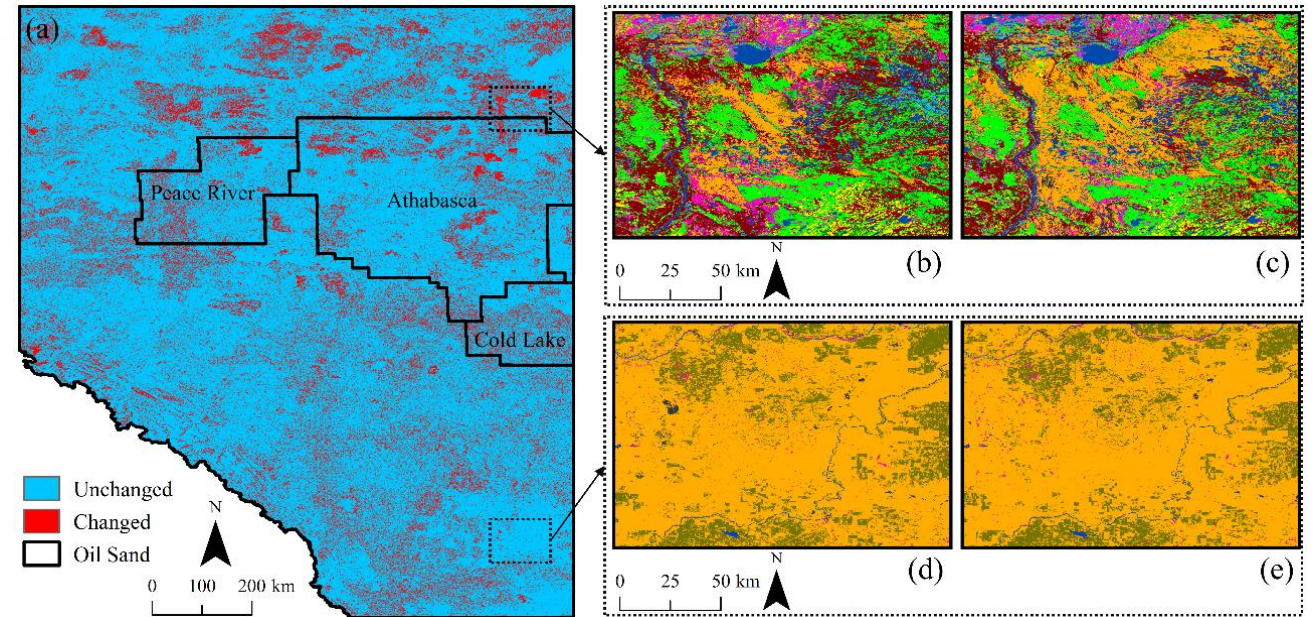


Class	Area (km ²)	% of Canada
Wetland		
Bog	375,416	3.71
Fen	671,344	6.64
Marsh	1,190,960	11.78
Swamp	853,734	8.44
Shallow Water	559,344	5.53
Total (wetland)	3,650,798	36.1
Non-wetland		
Deep Water	673,563	6.66
Forest	1,565,731	15.46
Grassland	1,062,753	10.51
Cropland	562,112	5.60
Barren	2,265,214	22.40
Snow	330,617	3.30
Total (non-wetland)	6,459,990	63.94

Results Examples: Wetland Change Assessment in Alberta



Base wetland map

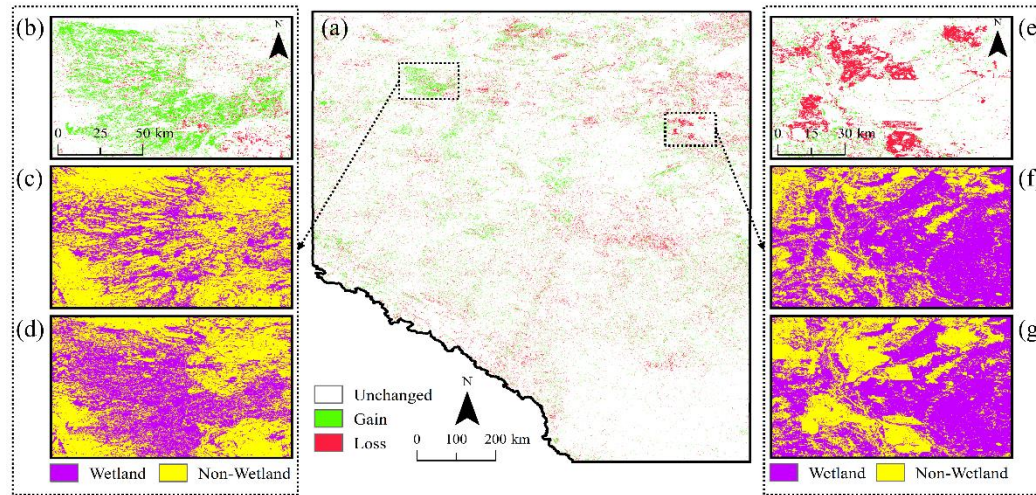


Changed: 18% (~130,000km²)

Unchanged: 82% (~542,000km²)

More changes over the north and north-east regions, as well as oil sands (e.g., 23% in Cold Lake)

Results Examples: Wetland Change Assessment in Alberta

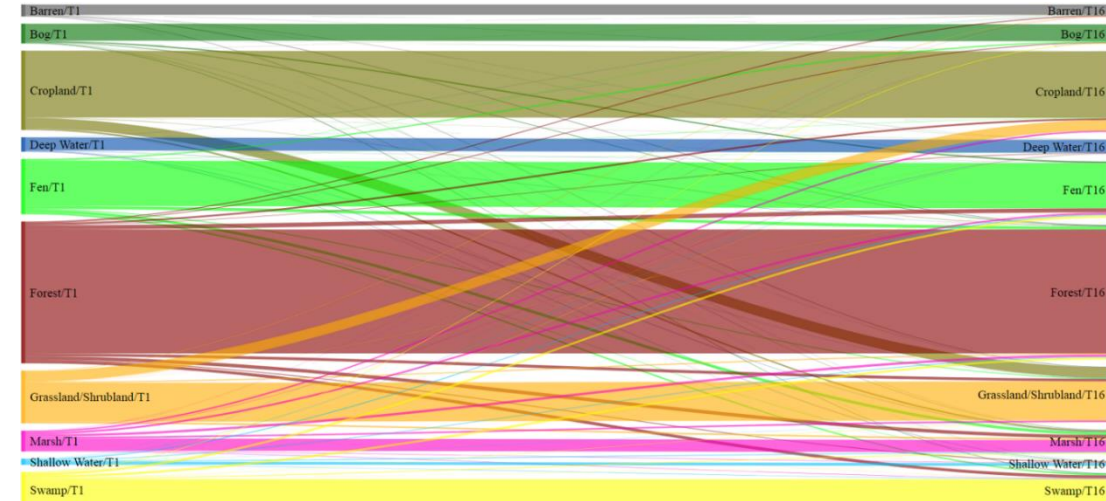


Wetland Loss: 22,000 km² (Wetlands to Forest and Grassland/Shrubland)

Wetland Gain: 24,000 km² (Forest has changed to wetlands, especially Swamp and Fen)

Area: Forest (209,000km²), Fen (84,000km²)

Large transitions between Grassland ↔ Cropland (29,000km²), Forest → Wetlands (18,000km²), Fen → Forest (6,000km²)



Questions?

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For more information, see
<https://scholar.google.ca/citations?user=RbHBNbYAAAAJ&hl=en>



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