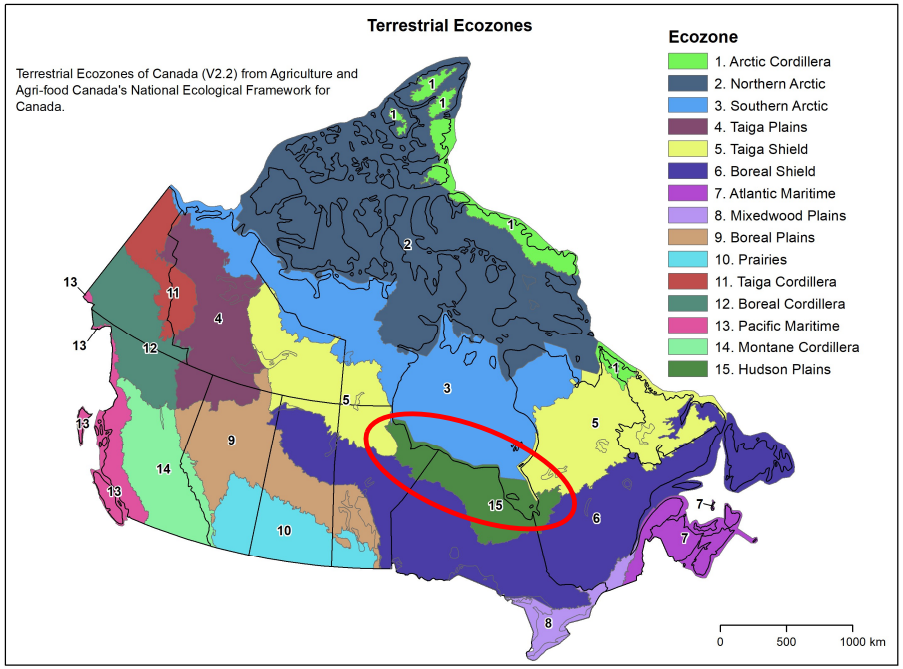
Ecosystem Extent Mapping of the Hudson Bay Lowlands: CEOS Demonstrator

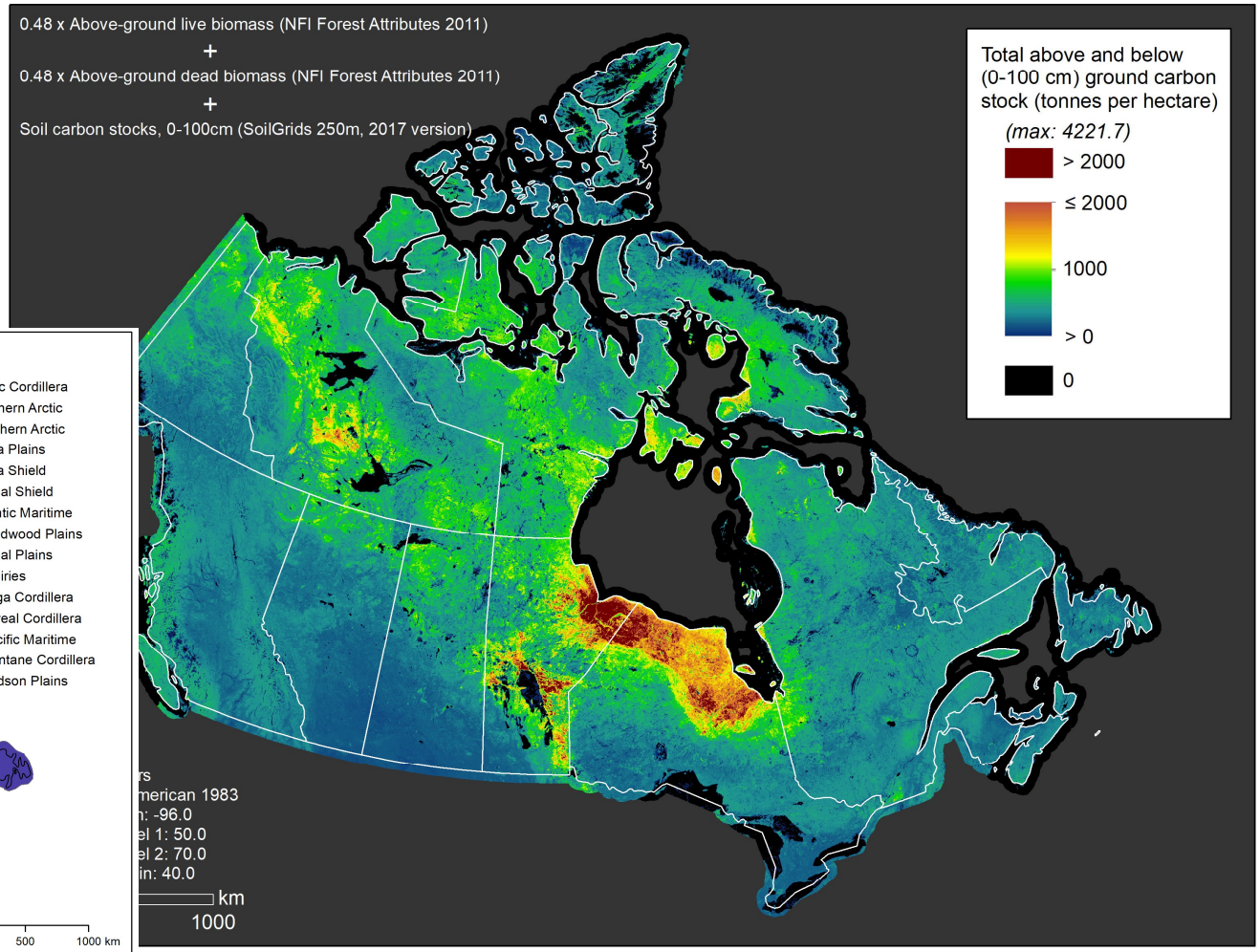
Jason Duffe
Geomatics Research
Wildlife and Landscape Science

Environnement et Changement climatique Canada
Environment and Climate Change Canada

Where is HBL?

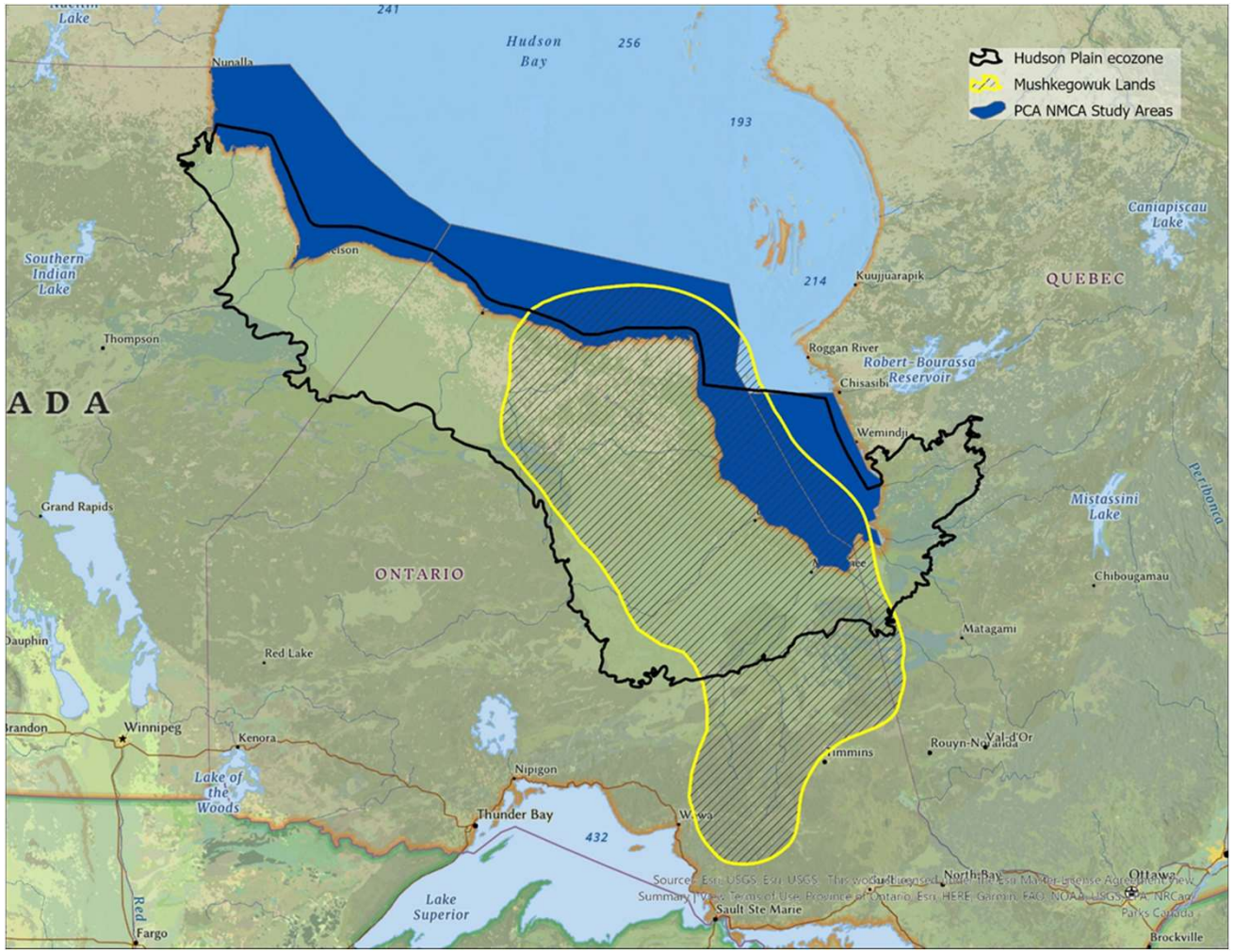
320,000 sq. km

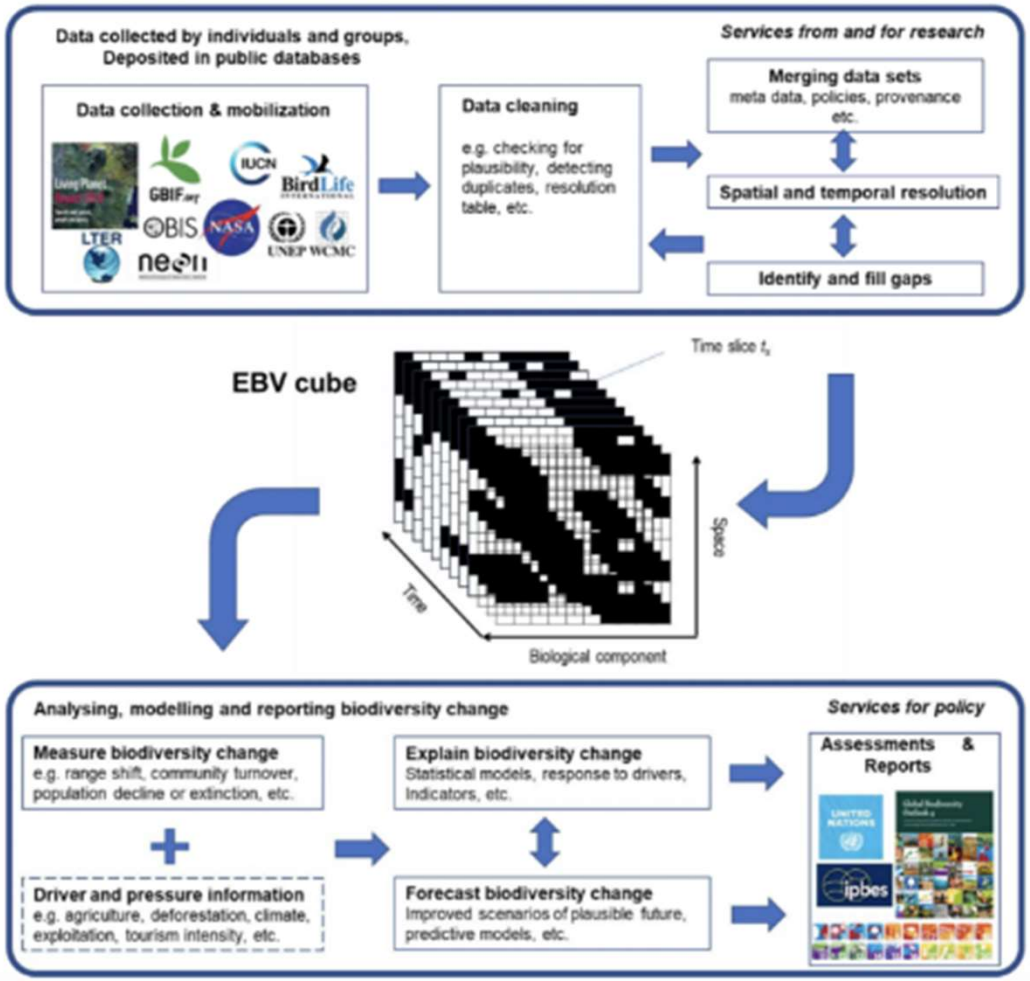




Why Hudson Bay Lowlands?

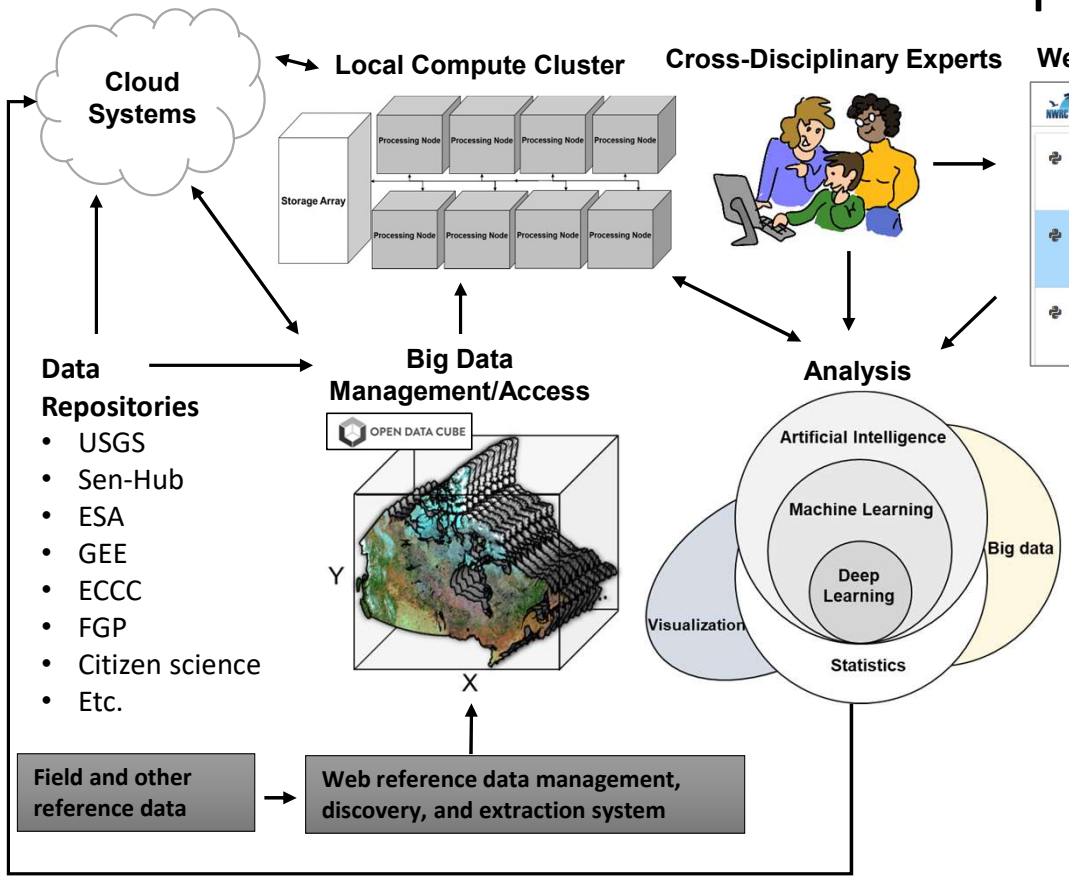
- Hudson–James Bay Lowlands Biodiversity Conservation and Sequestration Initiative – post COP 26 (2021)
  - The objective is to assess biodiversity and carbon values, in particular for peatland, wetland, coastal, and marine ecosystems in the Hudson Bay–James Bay Lowlands, and weave Western science and **Indigenous knowledge** to inform the range of conservation efforts in the region.
- Nature based Climate Solutions – Earth Observations to inform GHG Reporting from LULC, National Wetland Inventory (coastal and peatlands)
- Emissions Reductions/Avoidance – Ecosystem Mapping across Canada
- GEOBON/IPBES - Global Biodiversity Framework – Target 21

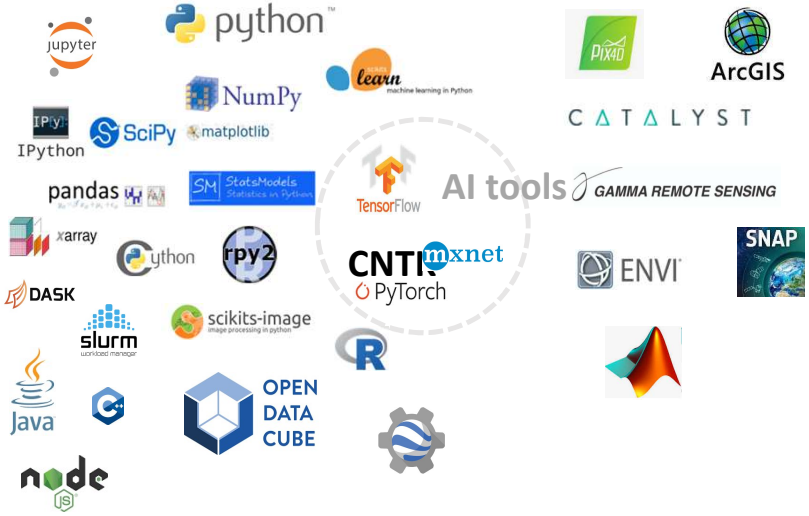




Source: adapted from Schmeller et al. 2017

NWRC-Geomatics: Acquiring and transforming data into information at appropriate scale





CEOS HBL Demonstrator Goal and Objectives

The overarching purpose for the demonstrator is to convey how satellite remote sensing is essential for mapping and monitoring ecosystems.

- To estimate the extent of each ecosystem class and ecotype within the ecozone, providing valuable information for biodiversity assessments, carbon cycling studies, and conservation planning.
- To generate a detailed ecosystem map of Wapusk National Park by combining a variety of Earth Observation and other data sources with advanced Machine Learning Classifiers
- To estimate the extent of each ecosystem and ecotype within the park, providing valuable information for conservation and management purposes and a foundation for future research and monitoring initiatives focused on ecosystem dynamics and changes.

Wapusk National Park Ecotype/Vegetation Mapping

GET – 3 – Functional Groups

CNWI	Swamp		Bog			Fen						Coastal			Upland (Tundra)				
Structure	Wooded	Shrubby	Wooded		Shrubby	Open	Shrubby		Wooded		Graminoid			Shrubby	Graminoid		Shrubby		
Alberta Wetlands Classification	Coniferous Swamp	Shrubby Swamp	Coniferous Bog		Shrubby Bog	Open Bog	Poor Shrubby Fen	Rich Shrubby Fen	Poor Coniferous Fen	Rich Coniferous Fen	Poor Graminoid Fen	Rich Graminoid Fen	Saline Fen	Shrubby Saline Fen					
Ecotype (CNVC)	Not in field data	Riparian Tall Willow	Spruce Lichen Bog	Spruce Sphagnum Bog	Not in field data	Sphagnum Bog	Willow Birch Shrub Fen		Larch Sphagnum Fen	Larch Sedge Fen	Poor Sedge Fen	Rich Sedge Fen	Coastal Rich Fen	Graminoid Willow Salt Marsh	Coastal Tall Willow - Netvein Willow	Lymegrass Shoreline	Grass Heath Upland	Dry Dras Heath	Moist Rhododendron	Lichen Peat Plateau Bog
RS Map																			

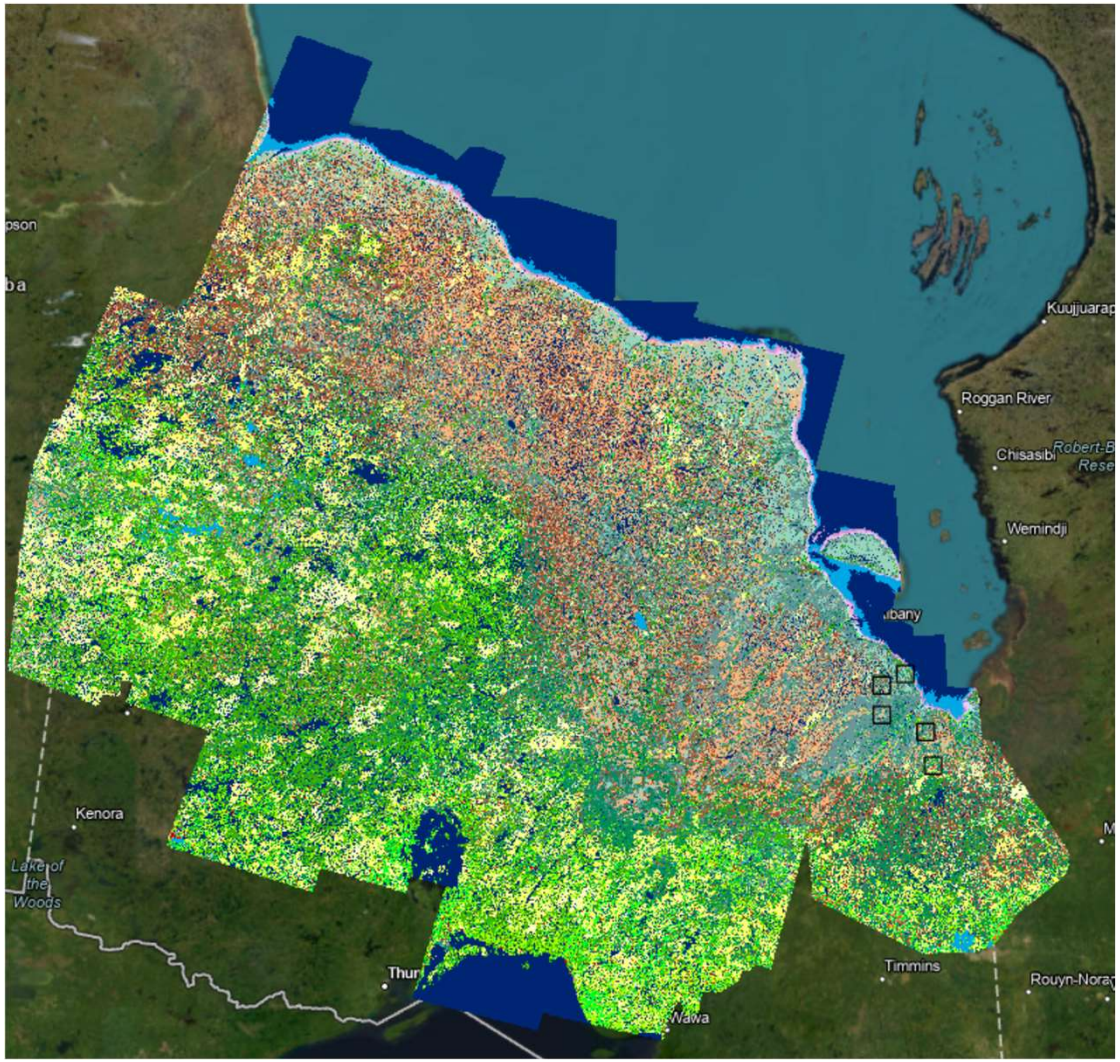
IUCN Global Ecosystem Typology - Hierarchical

Approach – CEOS Demonstrator

- The work will use advanced AI algorithms and other methods to combine data from several satellite sensors, *in situ* biodiversity data, and data from other sources.
- It will utilize the CEOS Analytics Laboratory (running on an Open Data Cube, ODC) developed by the CEOS System Engineering Office, providing technical assistance in setting up that infrastructure.

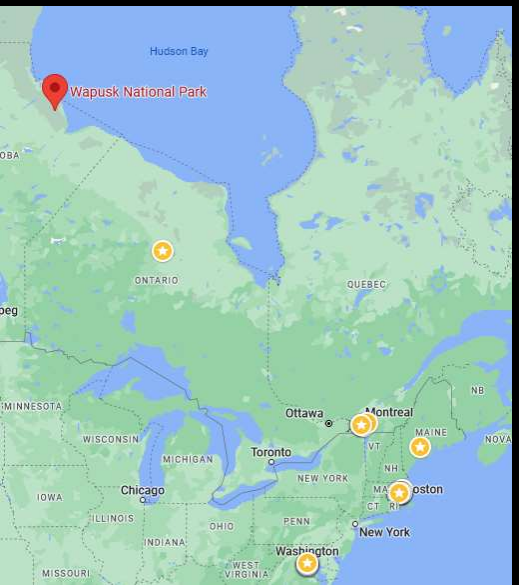
- ODC core datasets (Landsat, Sentinel) – all of HBL

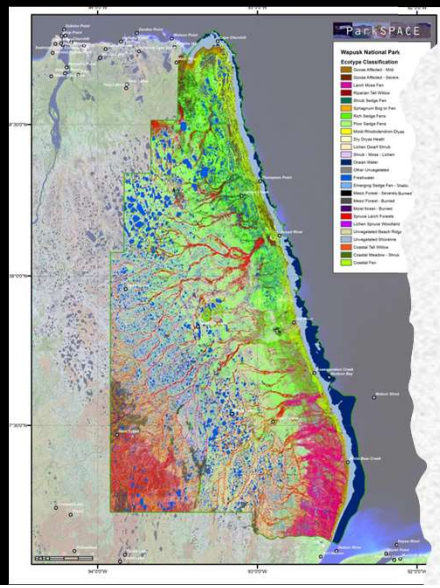
- Obtain hyperspectral satellite data (ENMAP), ALOS L-Band, and TANDEM-X (12m DEM) - Wapusk National Park.



FarNorth_LandCover_Class_Grid_UTM16

- -99 Other
- -9 Cloud/Shadow
- 1 Clear Open Water
- 2 Turbid Water
- 3 Intertidal Mudflat
- 4 Intertidal Marsh
- 5 Supertidal Marsh
- 6 Fresh Water Marsh
- 7 Heath
- 8 Thicket Swamp
- 9 Coniferous Swamp
- 10 Deciduous Swamp
- 11 Open Fen
- 12 Treed Fen
- 13 Open Bog
- 14 Treed Bog
- 15 Sparse Treed
- 16 Deciduous Treed
- 17 Mixed Treed
- 18 Coniferous Treed
- 19 Disturbance - Non and Sparse Woody
- 20 Disturbance - Treed and/or Shrub
- 21 Sand/Gravel/Mine Tailings
- 22 Bedrock
- 23 Community/Infrastructure
- 24 Agriculture





CEOS Demonstrator

- Wapusk National Park
- 11,475 km²

CEOS Demonstrator – Accomplishments to-date

- Standardized the vegetation from our field based training to the ecotype schema
- Assessed non-EO predictor variables

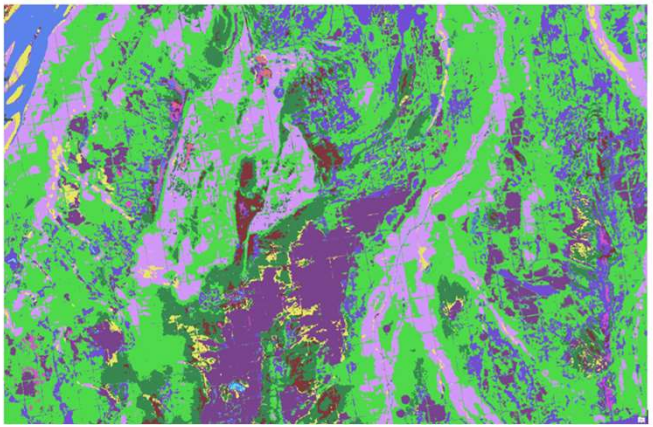
- Introduction to cloud-based SEO Data Cube with help from CSIRO
  - Developed & assessed classification methodologies (CNN & Unet) using open data products (Sentinel)
  - Applied to test sites in British Columbia & HBL
- Acquired & downloaded ALOS2-PalSAR2 data over Wapusk NP
  - Understanding processing needs with CEOS SEO

Preliminary U-Net (Convolutional NN) Results

Applied on our local HPC

Trained – using Wapusk data

Classified – Moosonee area



Challenges and Opportunities

- New sensor platforms
  - ECCC has expertise in hyperspectral EO but not with ENMAP
  - ALOS into Open Data Cube
  - How to deal with hyperspectral data in data cubes
- Combining hyperspectral and SAR using neural networks for ecosystem classification
  - Cutting edge research

- Demonstrate essential role of new EO sensors for ecosystem extent mapping
- Increase ability to discriminate wetland ecosystems with L-band SAR
- Assess role of hyperspectral data for ecosystem discrimination
- Provide insights into which sensors/data are most important for mapping different ecosystem levels (sensitivity analysis)
- Provide basis for further work on space-based EO for ecosystem mapping
- Potential to apply to other ecosystems

HBL Demonstrator – Coordination of Observations and Analytics

Committee on Earth Observation Satellites

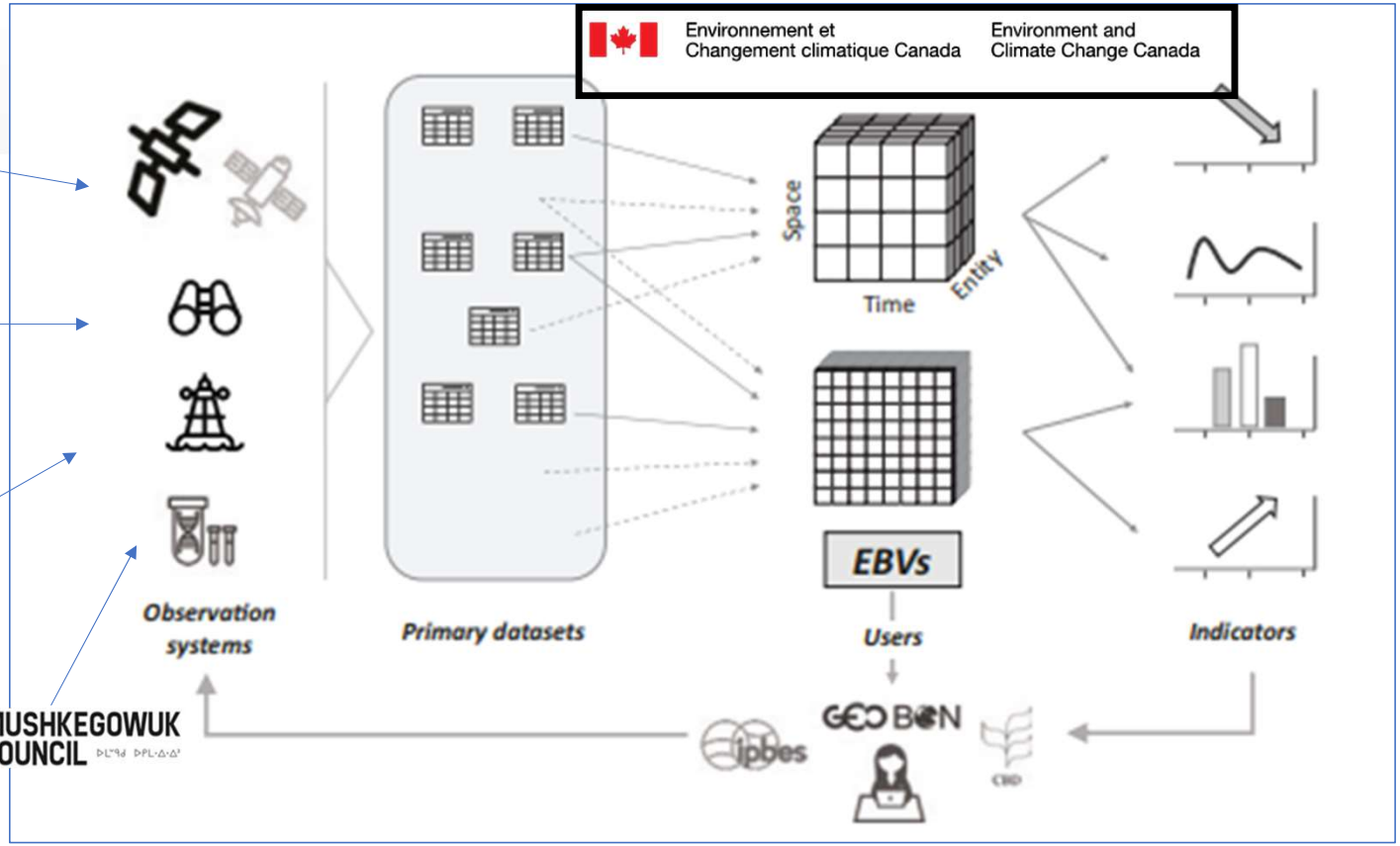
NatureServe

canadian museum of nature
nature
musée canadien de la nature

University of Toronto

UQÀM

University of Waterloo



Developing approaches for interoperable management of biodiversity data from different knowledge systems

GCRC

Carleton University

Objectives

- This project supports mediating or “weaving” data between scientific and Indigenous knowledge system as foundational to an informatics systems architecture
- an interoperable data system that integrates existing biodiversity research data and platforms, as well as data from community research streams to inform practical applications of biodiversity conservation

1. an advanced prototype design that would serve as the foundation for the development of a free and open-source software (FOSS) module of Indigenous data and knowledge, to be ingested into the Mushkegowuk Council Cree GeoHub

2. contributions to a conceptual framework design for interoperable biodiversity informatics infrastructure (CANBON, T21).

Hudson's Bay Lowlands CEOS EETT Demonsrator

Environment and Climate Change Canada

Jason.duffe@ec.gc.ca