



GREAT SLAVE LAKE

Water Resources

Mapping Long-Term Changes in the Hydroecology of
the Slave River Delta Using NASA Earth Observations

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STUDY AREA



Image Credit: NASA, OpenStreetMap



PARTNERS

**Fort Resolution
Métis Government**

**Deninu K'ue
First Nation**

**Akaiicho Territory
Government**

**Environment and
Climate Change Canada**

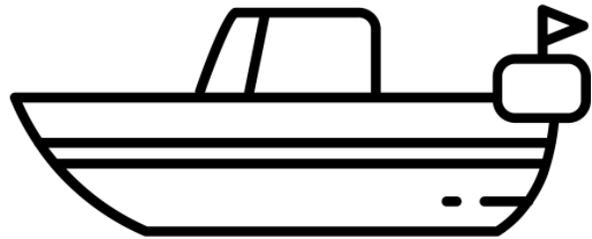


Great Slave Lake, Summer 2018

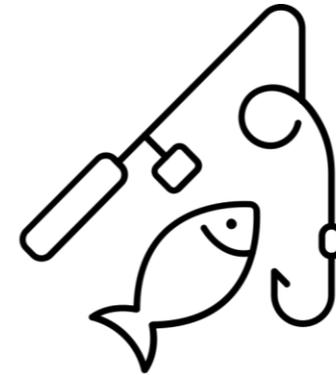
COMMUNITY CONCERNS



Wetland habitat



Water transportation



Fishing



OBJECTIVES

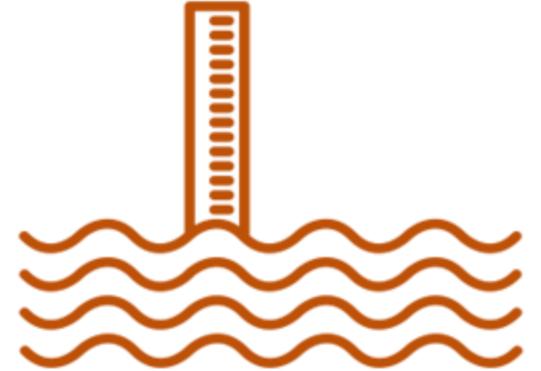
Surface Water



Land Cover



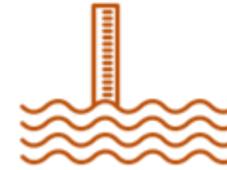
Water Balance



Study Period: 1984 to 2021



NASA EARTH OBSERVATIONS



Landsat 5

Thematic Mapper



Landsat 7

Enhanced Thematic Mapper Plus



Landsat 8

Operational Land Imager

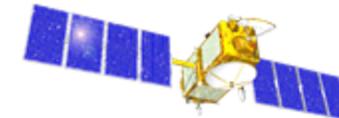
TOPEX/Poseidon

Poseidon-1 Altimeter



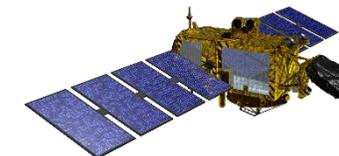
Jason-1

Poseidon-2 Altimeter



Jason-2

Poseidon-3 Altimeter



Jason-3

Poseidon-3B Altimeter



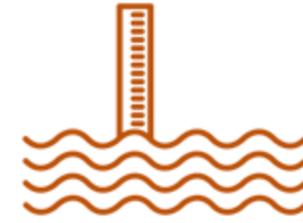
ANCILLARY DATASETS



- ▶ **Global Surface Water (GSW)** classification images from the European Commission Joint Research Centre



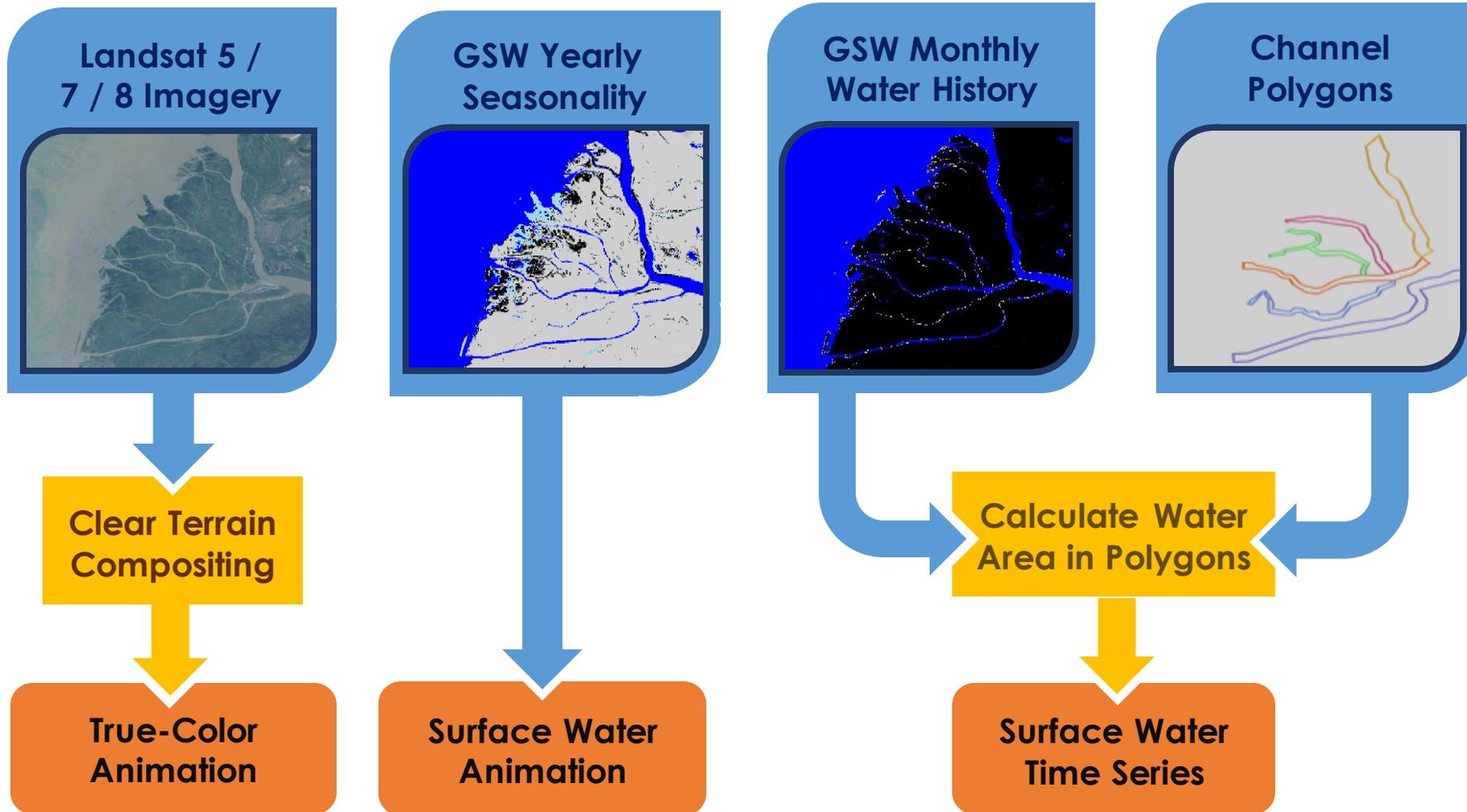
- ▶ **Wetland Type** classification images from the NASA Arctic-Boreal Vulnerability Experiment (**ABOVE**)



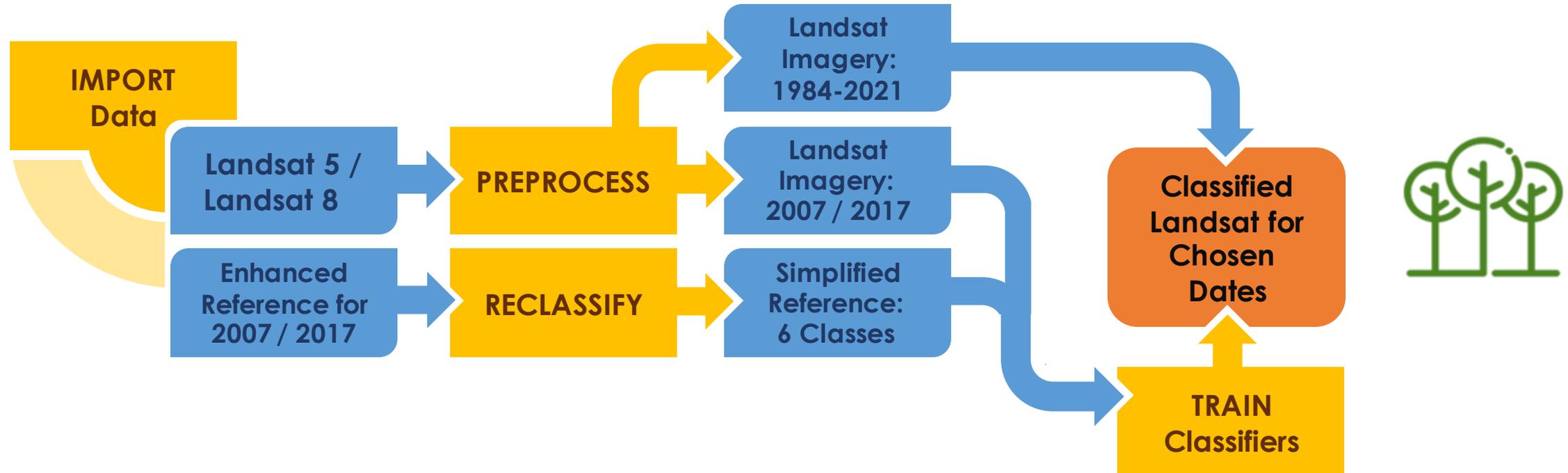
- ▶ NASA Daymet **daily precipitation** layers
- ▶ Digital Elevation Model + **drainage basin shapefiles** from Natural Resources Canada
- ▶ **River discharge** data from Environment & Climate Change Canada
- ▶ **Evaporation** data from European Centre for Medium-Range Weather Forecasting



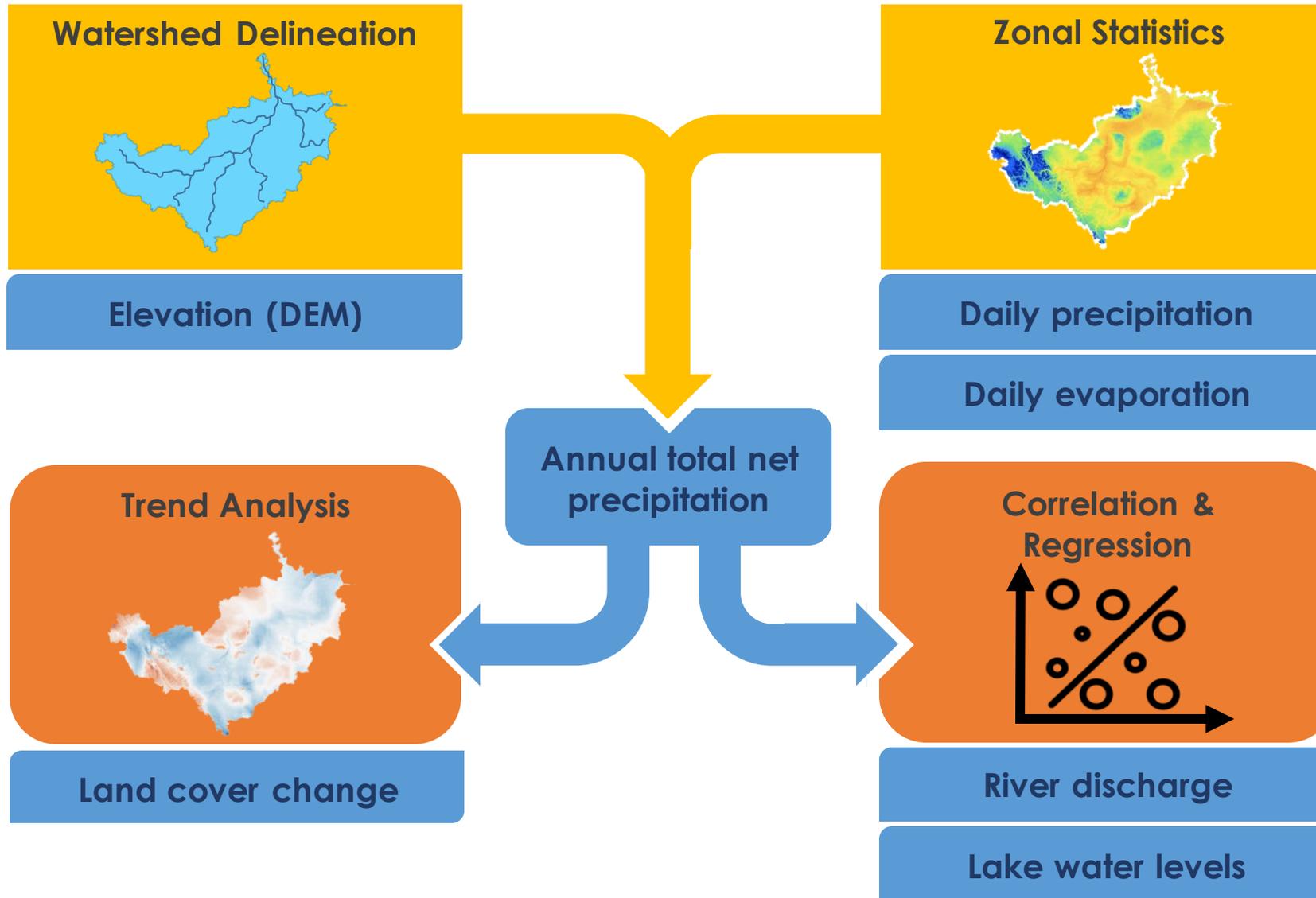
METHODS – SURFACE WATER



METHODS – LAND COVER



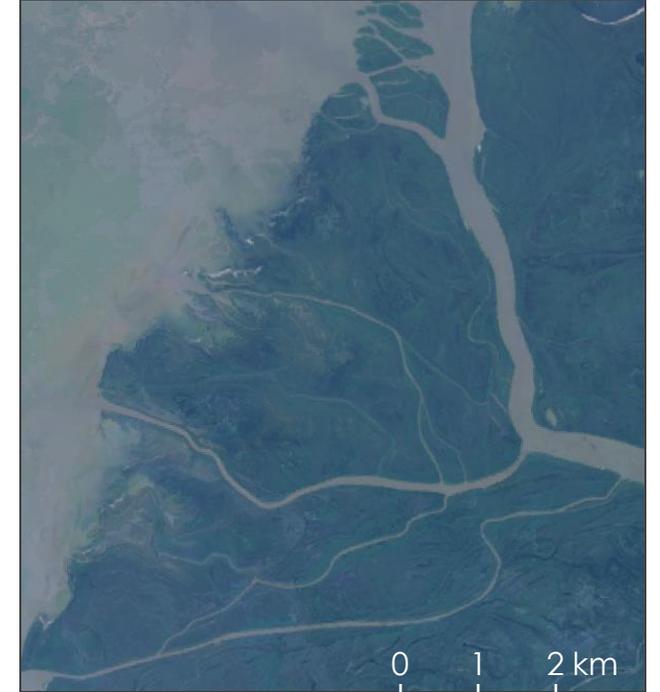
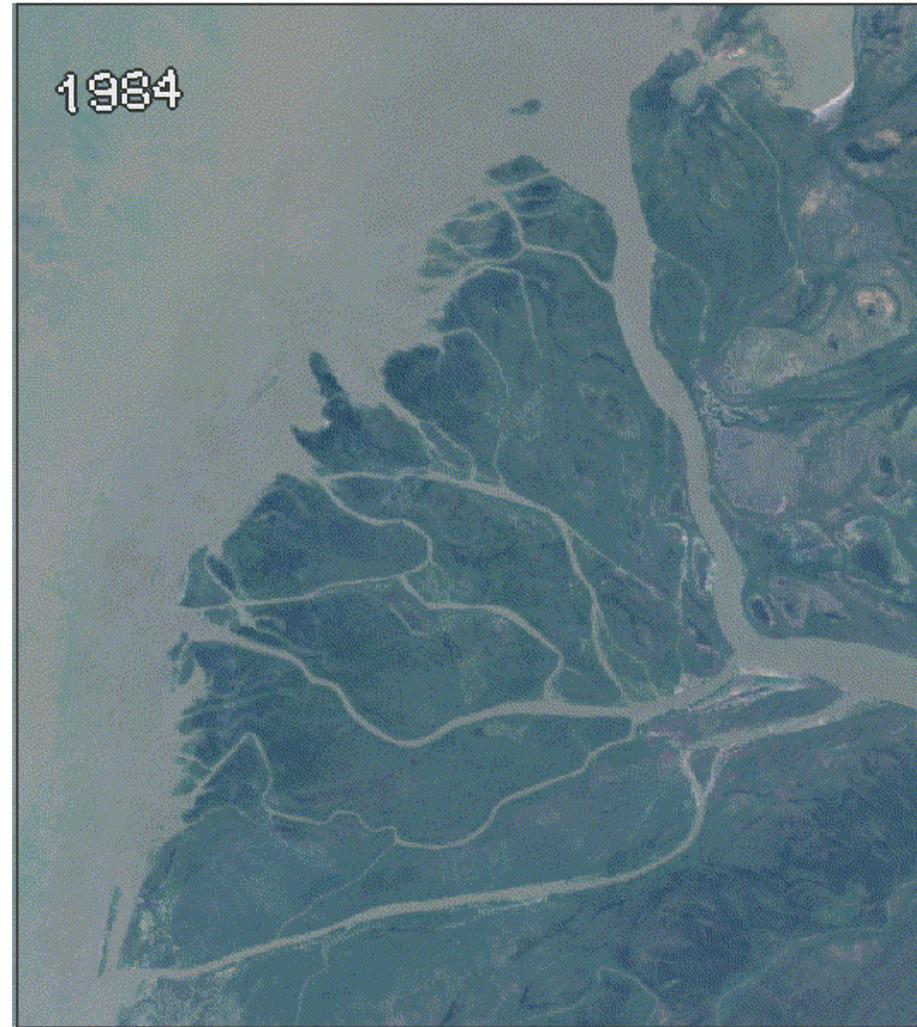
METHODS – Water Balance



RESULTS – SURFACE WATER



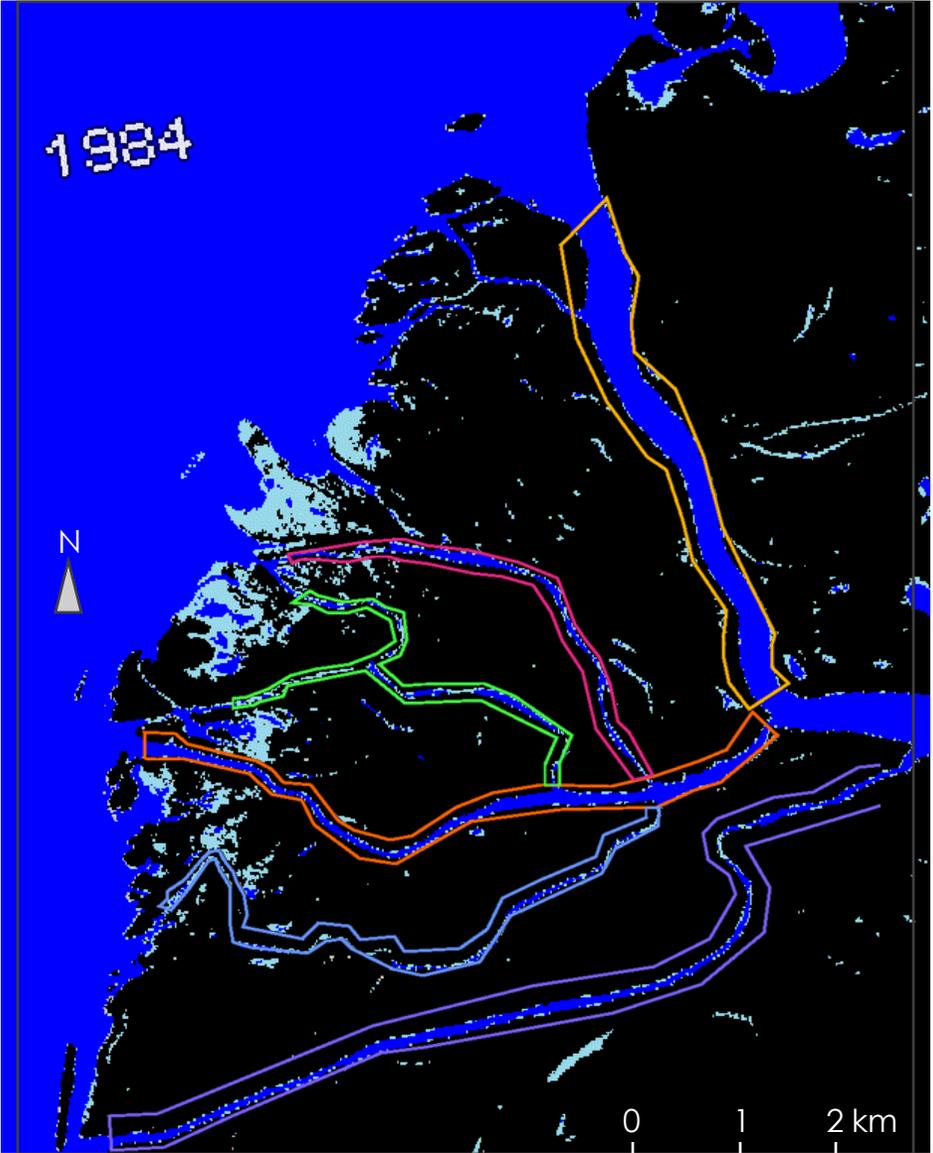
1984



2021

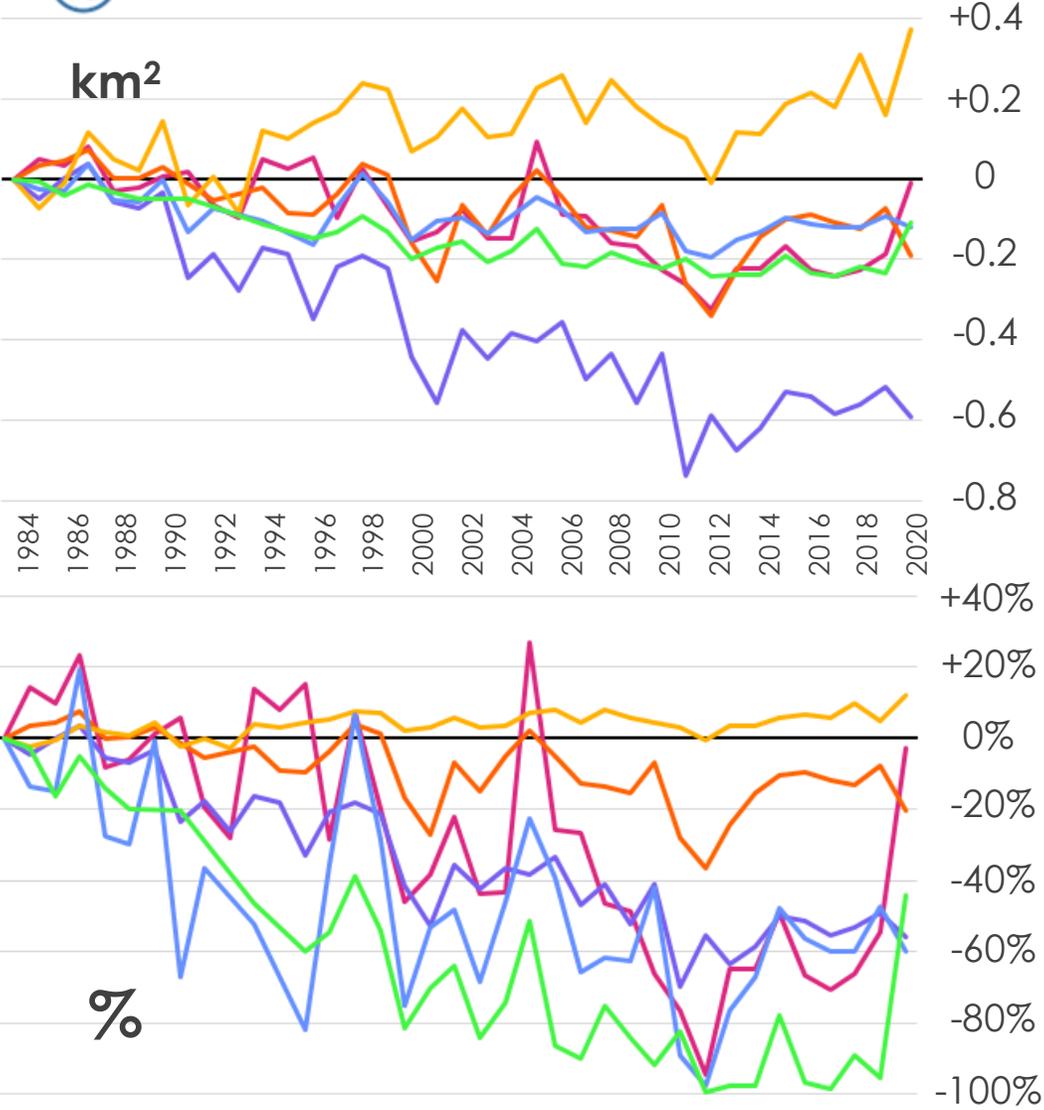


RESULTS – SURFACE WATER



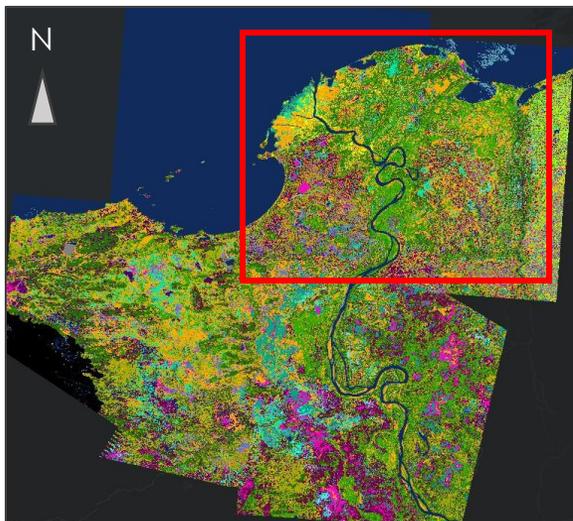
Channel Names:

- ResDelta
- East Channel
- Mid Channel East
- Mid Channel West
- West Channel
- Old Steamboat

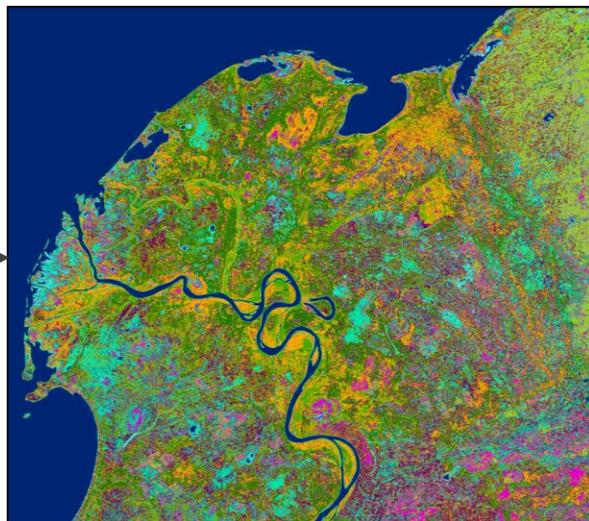


Changes in surface water area since 1984

RESULTS – LAND COVER



June 2007 – October 2007
ABoVReference



June 2007 – October 2007
Landsat 5

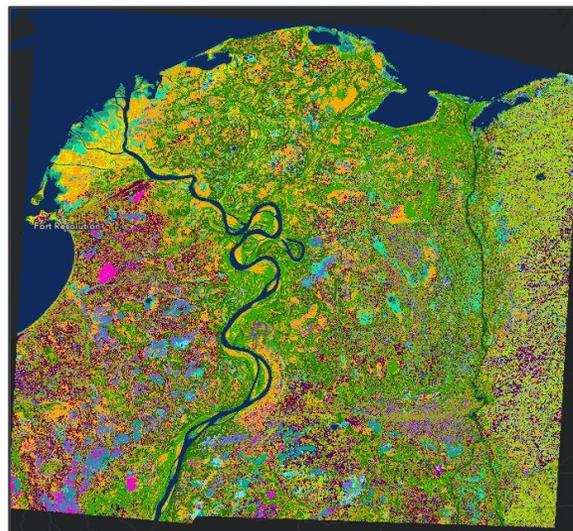
Landsat 5

Random Pixels Sampled: 140,000

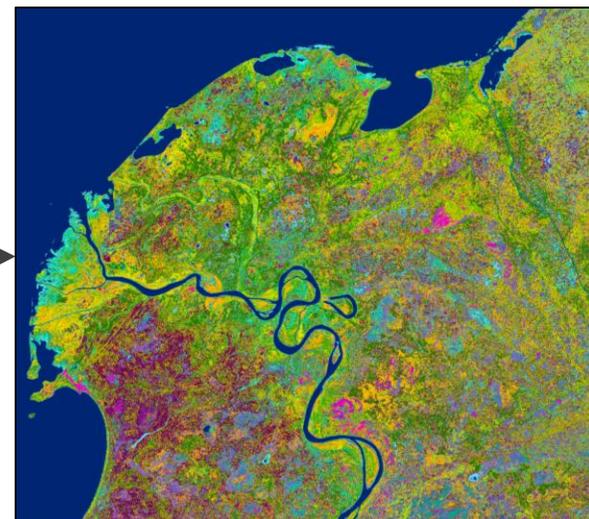
Training/Testing Ratio: 70/30

Training Accuracy: 98.6%

Validation Accuracy: 60.7%



June 2017 – October 2017
ABoVReference



June 2017 – October 2017
Landsat 8

Landsat 8

Random Pixels Sampled: 140,000

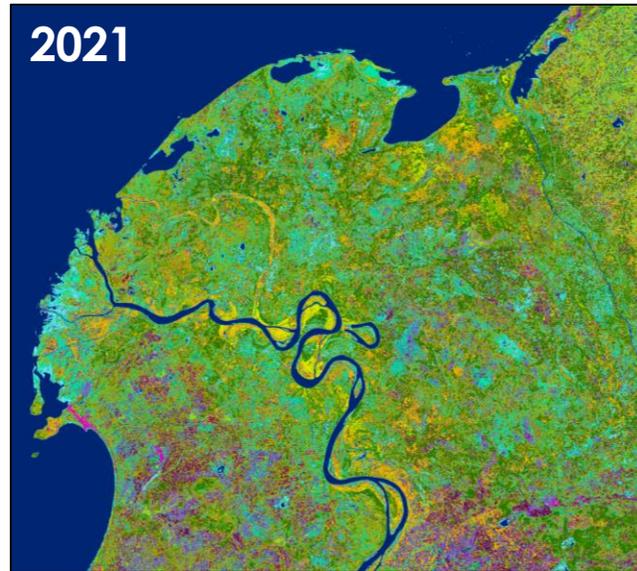
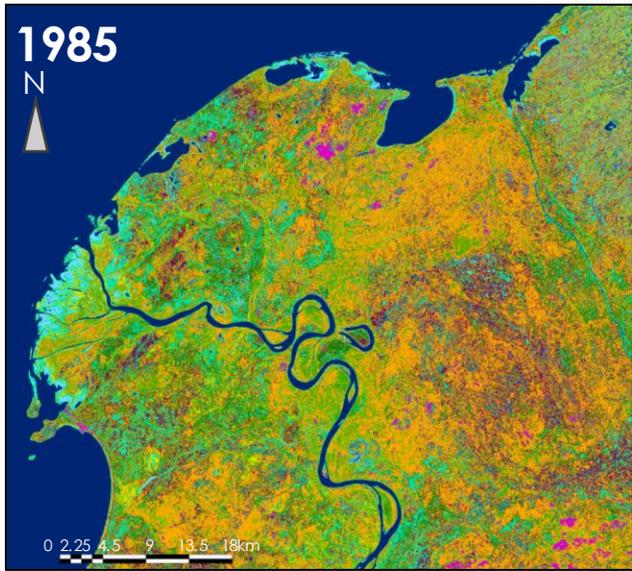
Training/Testing Ratio: 70/30

Training Accuracy: 98.7%

Validation Accuracy: 58.3%



RESULTS – LAND COVER



BEFORE



AFTER



Enhanced Wetlands Classification Land Cover

- | | |
|-----------------------|-------------------------|
| Water | Shrub Swamp |
| Floating Aquatic Veg. | Hardwood Swamp |
| Emergent Marsh | Conifer Swamp |
| Meadow Marsh | Upland Conifer Forest |
| Open Fen | Upland Deciduous Forest |
| Shrubby Fen | Upland Shrub |
| Treed Fen | Barren, Stone |
| Treed Bog | |

Simplified Wetlands Classification Land Cover

- | | |
|-----------------------|----------------|
| Water | Upland Forests |
| Floating Aquatic Veg. | Shrubland |
| Wetlands | Barren, Stone |

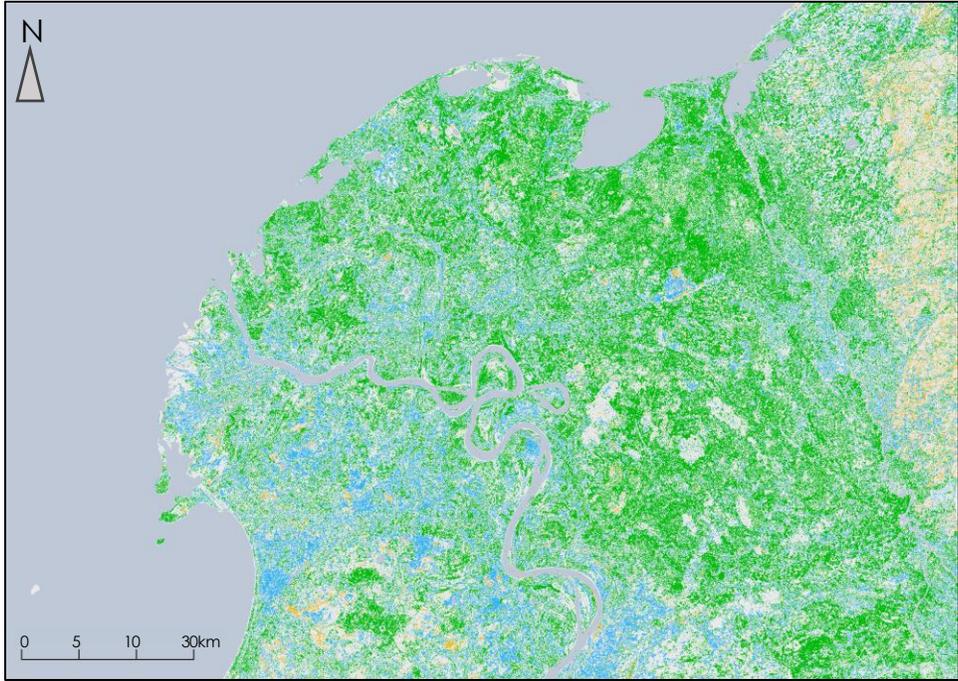
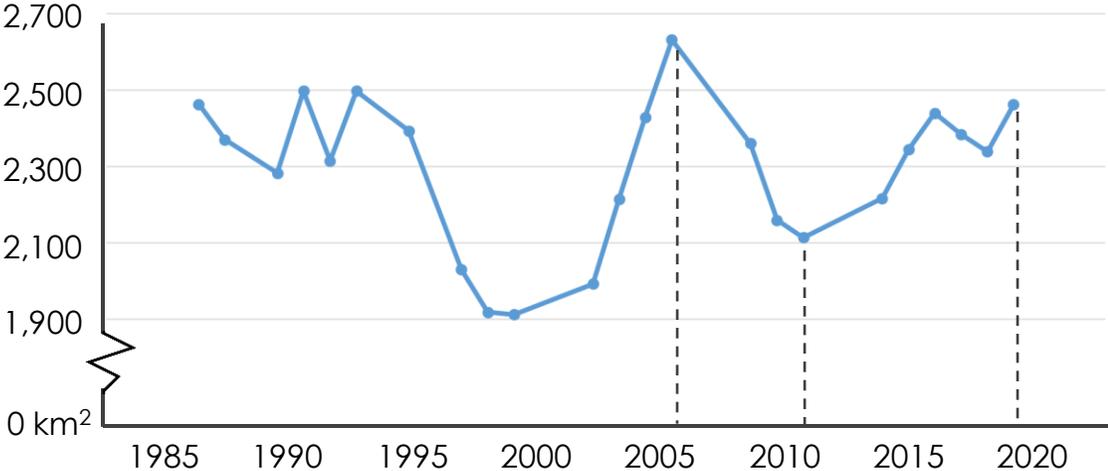
Icon Credit: Wisnu Khayzen



RESULTS – LAND COVER

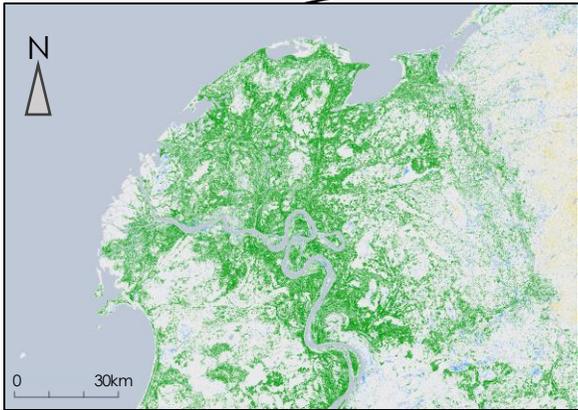


Wetlands surface area in Slave River Delta
3-year moving average, 1984-2021

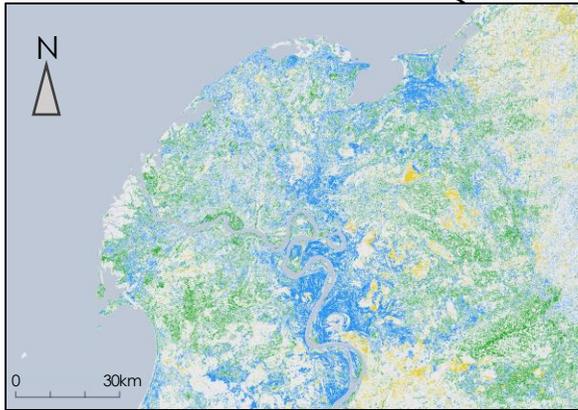


Change in Land Cover Relating to Wetlands 1984 & 2021

- Wetlands to Forest
- Wetlands to Shrub
- All Other Classes to Wetlands

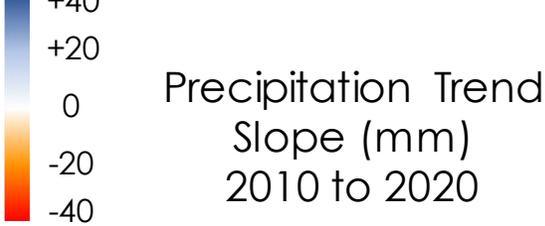
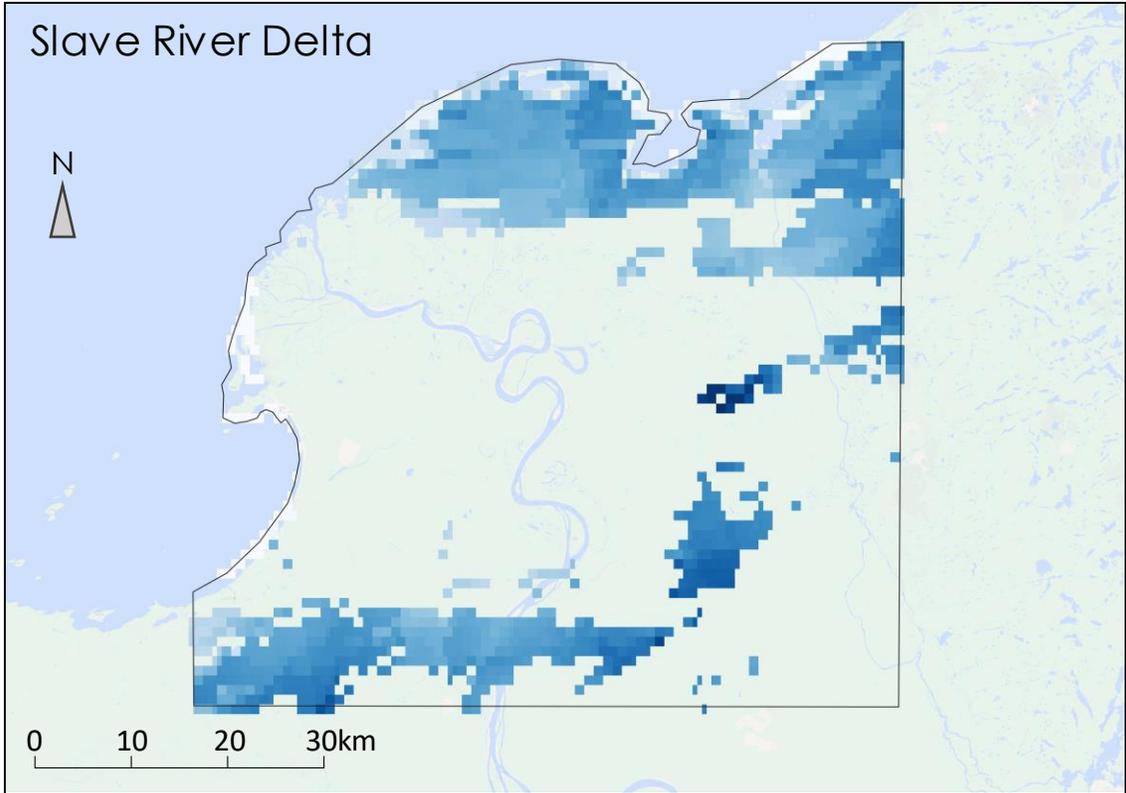
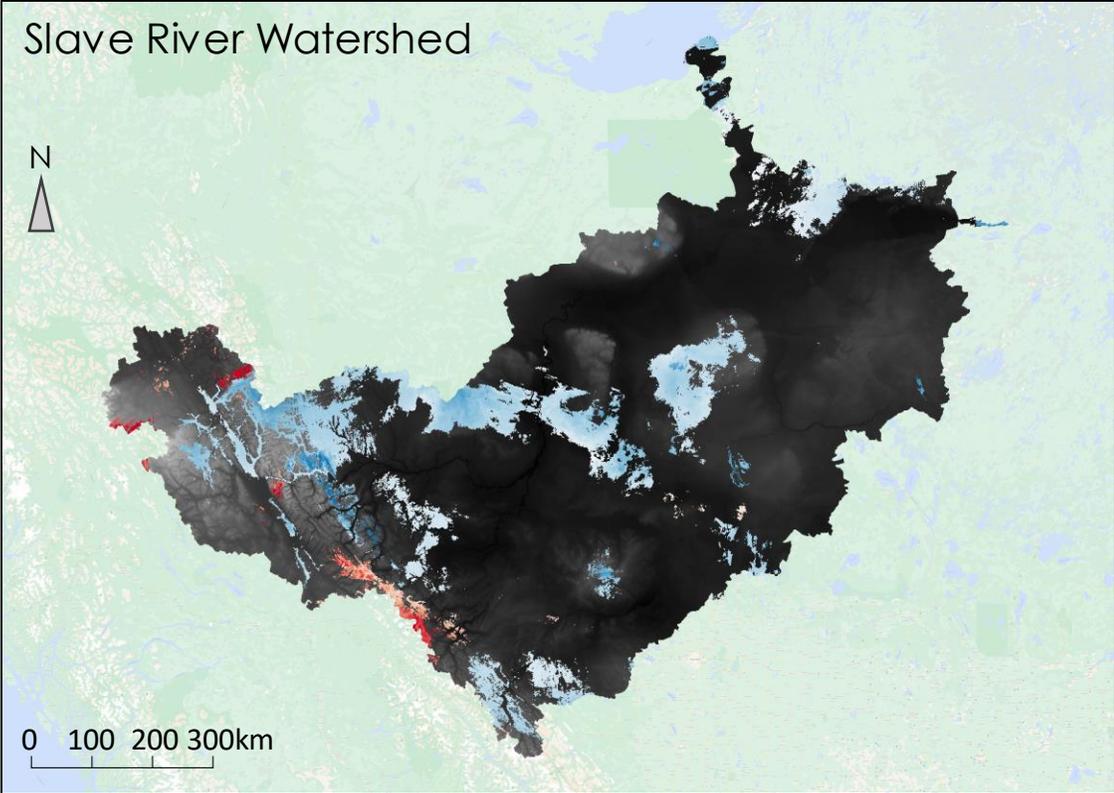
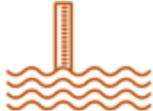


2005 to 2010

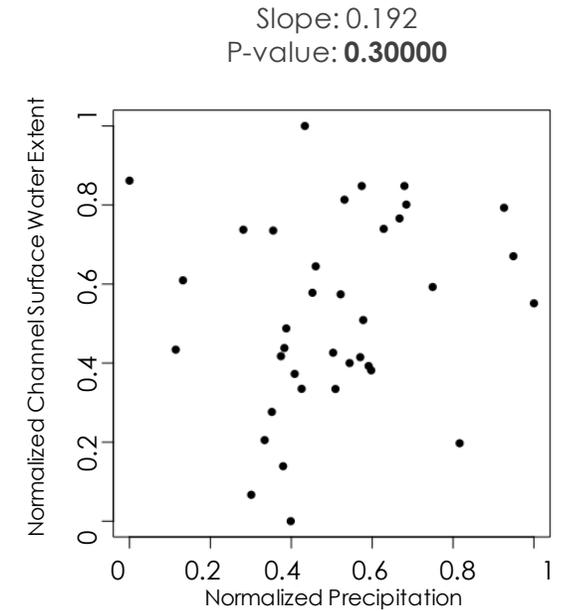
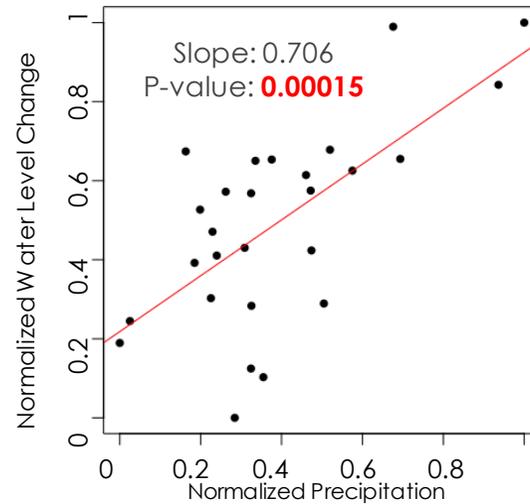
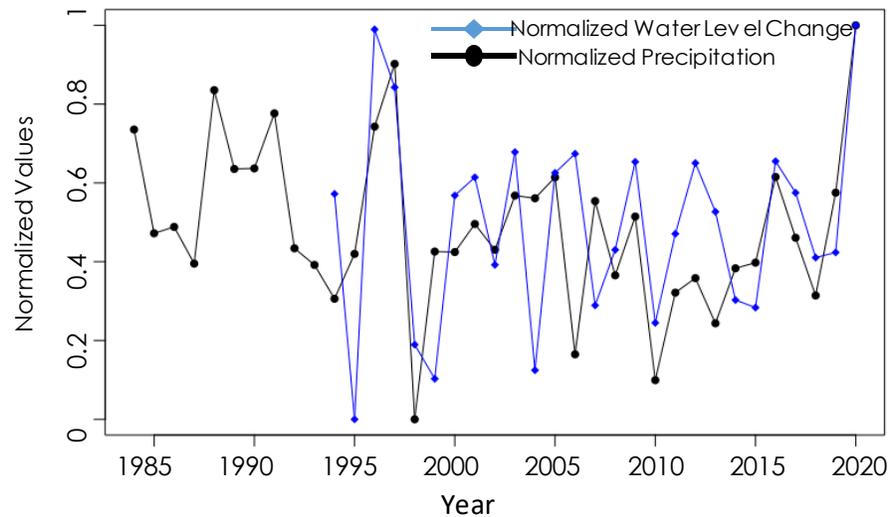
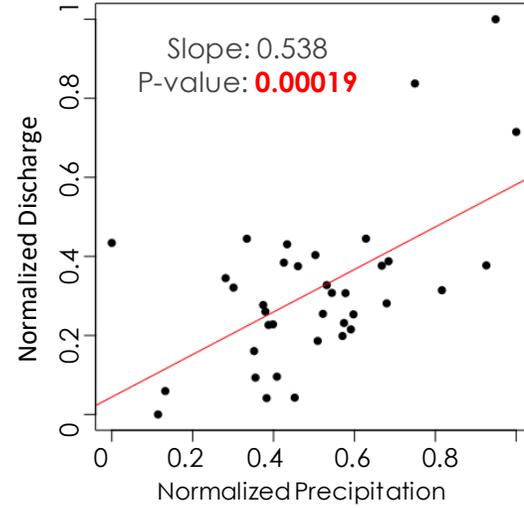
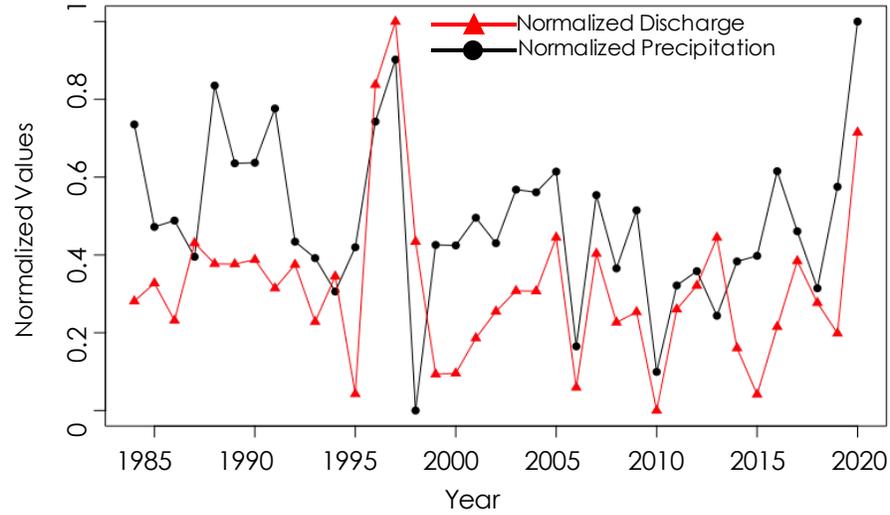
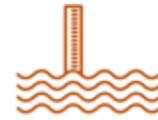


2010 to 2021

RESULTS – WATER BALANCE



RESULTS – WATER BALANCE



CONCLUSIONS



- ▶ Many waterways in the outer Slave River Delta, aside from the main channel, have been **shrinking over recent decades**.

- ▶ **Wetland extent** in the delta seems to rise and fall in **multi-year cycles** and may be partially associated with precipitation in the drainage basin.
- ▶ Some areas of the delta, especially in the **north and east**, seem to be shifting from **wetter to dryer vegetation** despite recent increases in precipitation.



- ▶ Regional precipitation contributes to river discharge, lake water levels, and land cover, but **channel shrinkage** may be **primarily a result of local sediment deposition** instead.

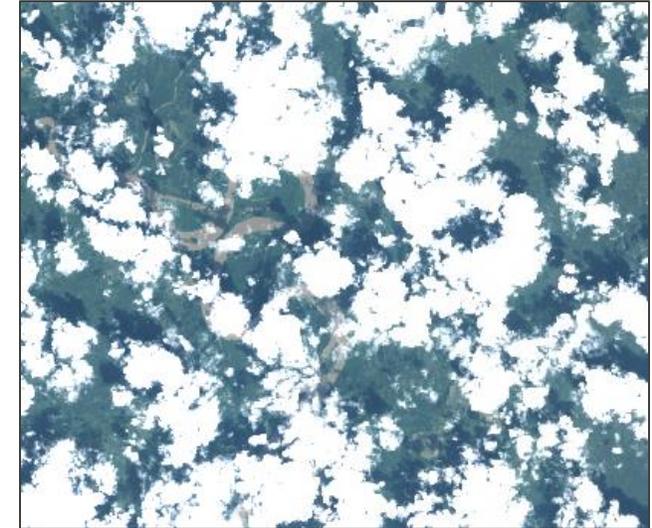


Errors and Uncertainties

- ▶ Relatively coarse pixel resolution for surface water analysis
 - ▶ Some changes are hard to discern in animations
 - ▶ Channel widths are difficult to calculate precisely



- ▶ Linear regression oversimplifies actual water balance dynamics
 - ▶ Precipitation in different regions doesn't run off at the same rates



- ▶ Lack of ground-truth data for classifier training and classification assessment
- ▶ Lack of calibrated, relatively cloud-free satellite images at high latitudes



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