River surface area and change detection methods for: *Climate sensitive methane release from Arctic rivers in sediment-laden channels (in prep, Dasari et al., 2025).*

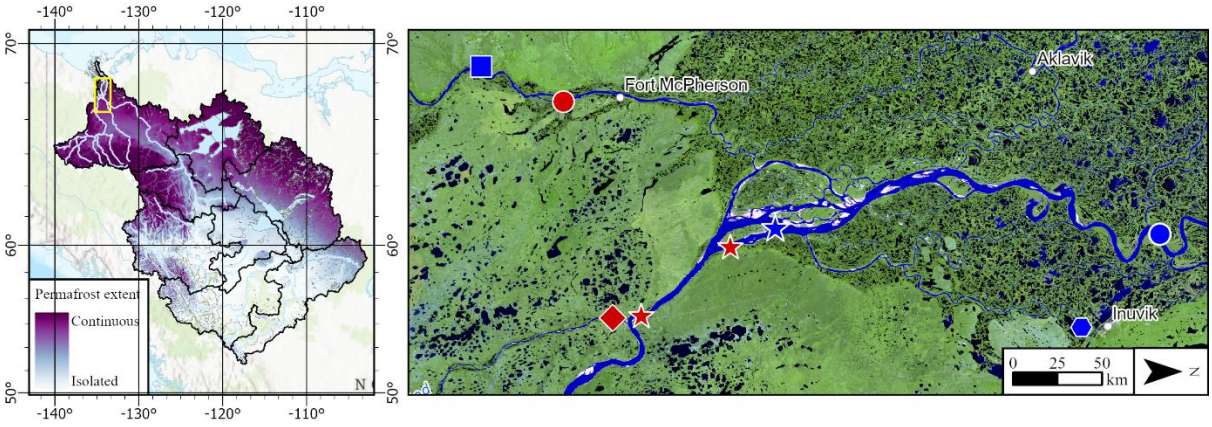

Figure 1. Overview map of study region and sampling locations.

Google Earth Engine workflow

The GEE script used to obtain satellite images and process water indices can be found here:

Mackenzie River CH_4 script

The script operates the following processes:

1. River surface area:
    a. Define area of interest
    b. Set user parameters (specify which satellite imagery/dates/scale to use)

Satellite imagery and pre-processing: to allow for the highest available level of spatial and temporal resolution, Sentinel-2 MultiSpectral Instrument (MSI) Level 2A (L2A) images were used since this gives a 10 m resolution (for the spectral bands used here) at 5-day intervals[1], and includes the spectral bands needed to calculate a water index. L2A data has already been corrected for atmospheric effects using the Sen2Cor processor[2].

    c. Set up functions:
        i. Cloud mask
        ii. Water index bands and formula

Water indices: Normalised Differenced Water Index (NDWI, Figure 2) was calculated for every ice- and cloud-free (<15%) image available between the end of June and start of October over 2020 to 2025, to create a 5-year average view (median pixel values). Also used specific dates as close to sampling as possible to create two additional (single date) datasets that most closely match the time of sampling.

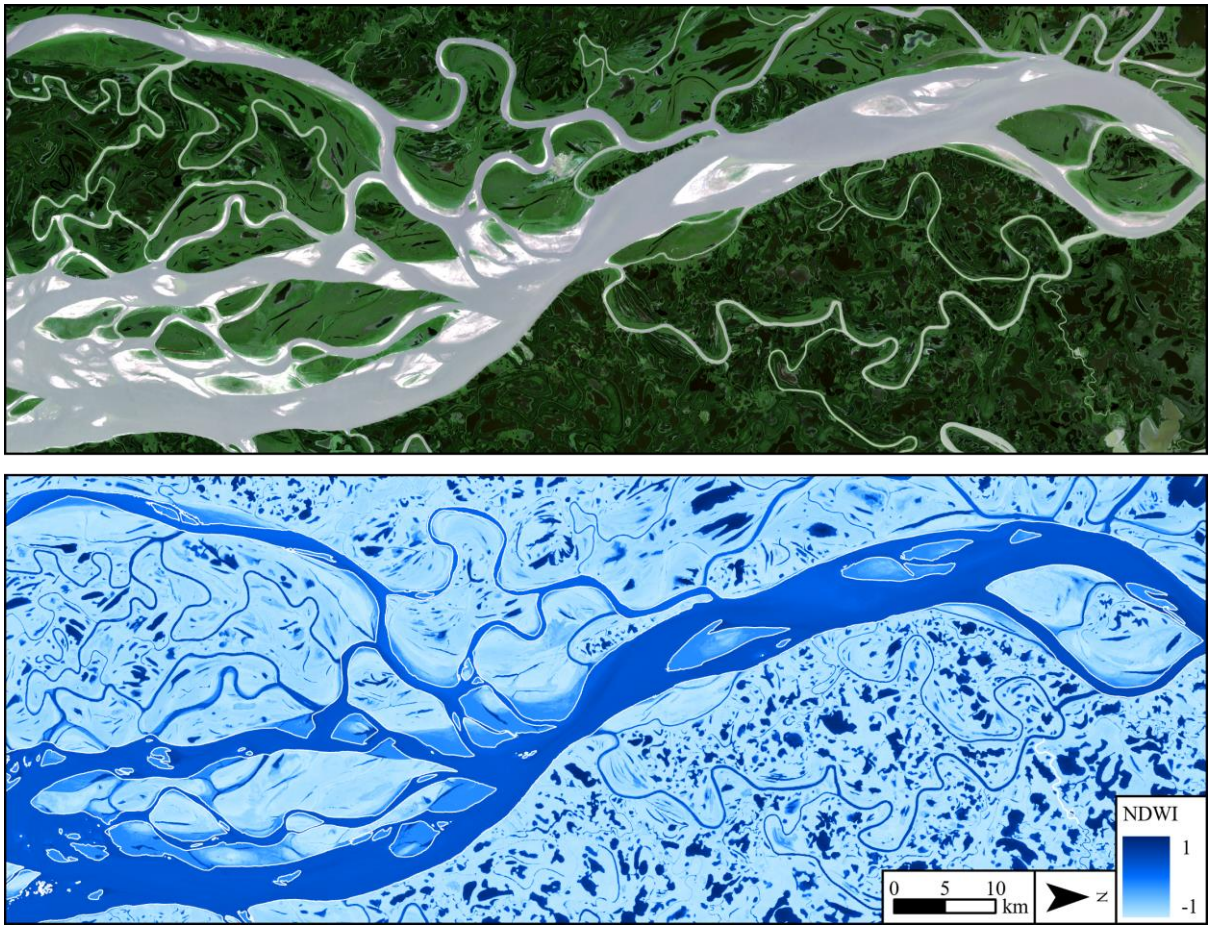

Figure 2: RGB true colour (top) and NDWI (lower panel) of the 2020-2025 summer composite images. The extracted area of interest is outlined in white.

NDWI uses Sentinel-2 MSI bands 3 (green) and 8 (near-infrared) to highlight water bodies, which strongly absorb light at those wavelengths:

$$NDWI = \frac{(B03 - B08)}{(B03 + B08)}$$

NDWI is reported from –1 to +1, with values > 0.5 typical of surface water[3].

d. Set up satellite image collection using above functions
e. Create composite NDWI and RBG images to get a 5-year average of channel area and export to Drive
f. As above but with date-specific images to align with sampling trips
g. Images then loaded into ArcGIS for onwards (manual) classification

2. Vitrekwa tributary breach:
   a. Define dates and area of interest
   b. Set up export function
   c. Loop through each defined date and export.

ArcGIS Pro manual classification

NDWI rasters were classified in ESRI ArcGIS Pro using Nautral Breaks (Jenks) classification. Class thresholds were then manually adjusted and QC'd using the raster histogram, and true colour and NDWI images, and the classified rasters were then polygonised (Figure 3).

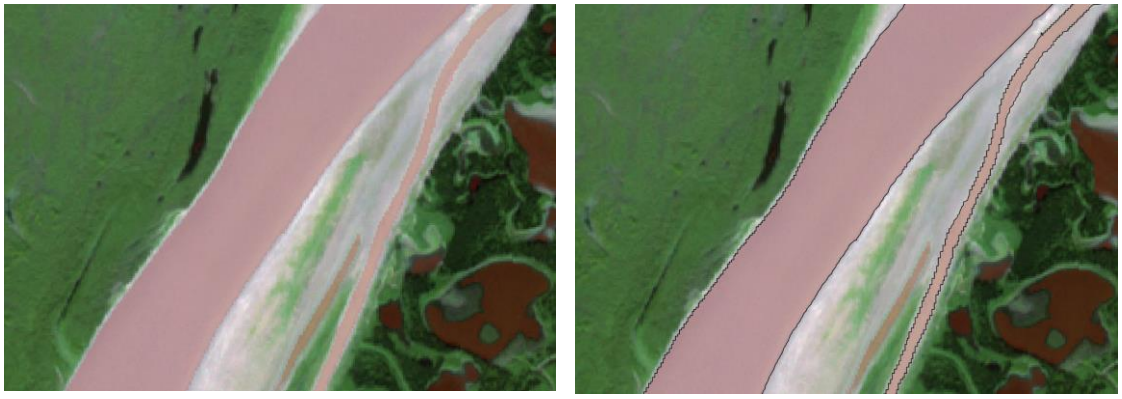

Figure 3. QC process showing RGB true colour overlain by a semi-transparent NDWI layer, highlighting water bodies in red and the resulting polygon outline on the right.

Everything except the relevant channel sections were omitted (Figure 4), and then the area of each polygon was calculated using the ArcGIS Pro 'Calculate Geometry' tool.

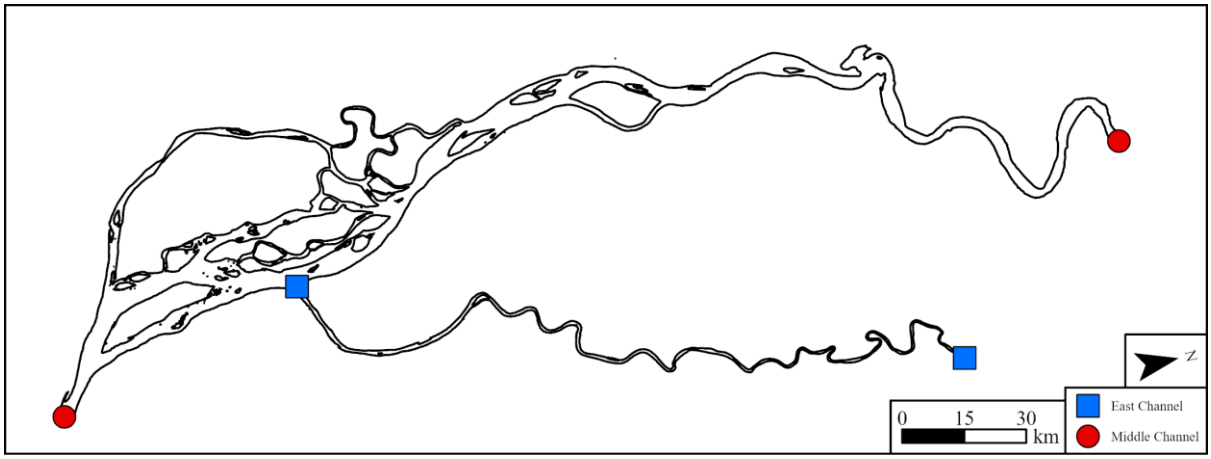

Figure 4. River surface area polygons derived from the 2020 – 2025 composite images.

The areas of the resulting river surface area polygons are detailed in Table 1:

Table 1: river surface area in m^2.

Site	2020 – 2025 summer composite (median)	October 2023	June 2024
Middle Channel	259,553,176.1	232,442,020.7	250,148,203.7
East Channel	22,228,933.6	18,821,714.1	21,273,876.9

Vitrekwa-Peel tributary: change visualisation

The channel breach occurred during the 2025 spring melt season between the 19th and 27th of May. Satellite imagery of the area (Figure 3) was obtained from:

- 2000 - 2010: Landsat 7 ETM+ C2 L1 (accessed via USGS Earth Explorer)
- 2015: Landsat 8/9 OLI/TIRS C2 L2 (accessed via USGS Earth Explorer)
- 2020 onwards: Sentinel-2 MSI L2A (accessed via GEE Sentinel_SR Collection)

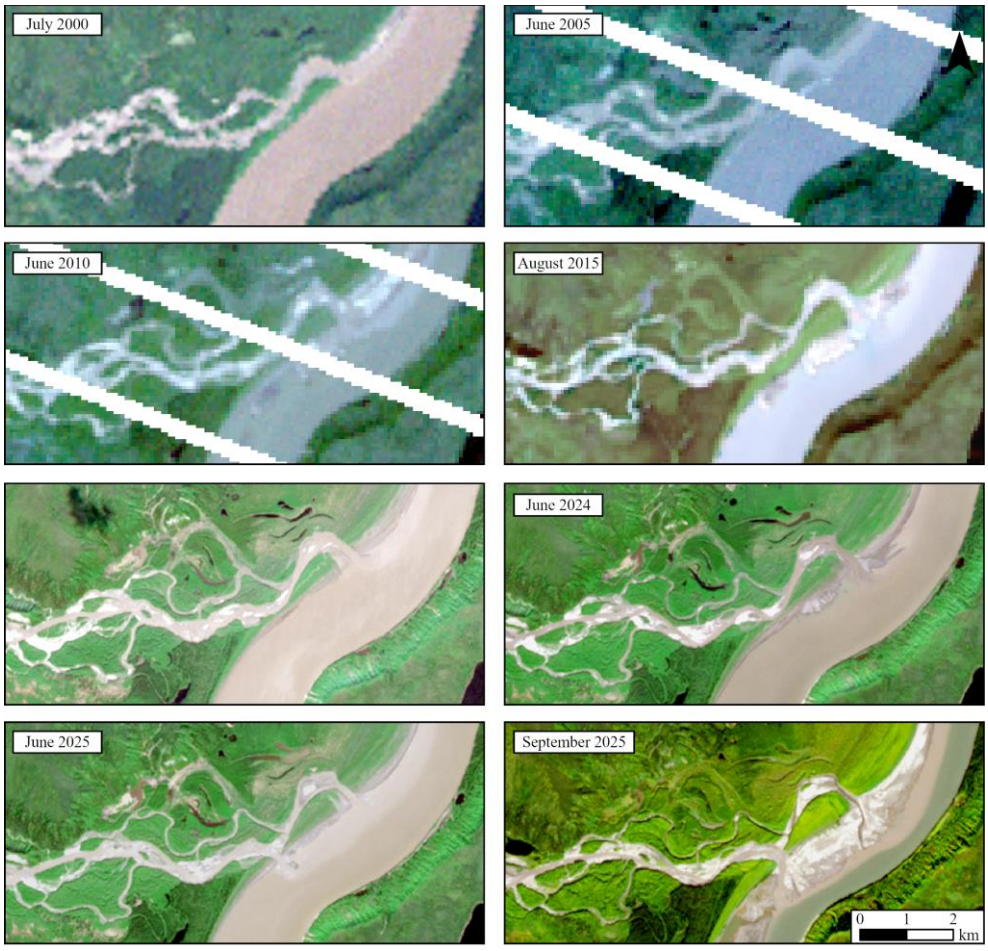

Figure 3. Vitrekwa-Peel bank breach (shown in RGB true colour).

References

1. ESA (2025) Sentinel-2 L2A, Sentinel Hub. Available at: https://docs.sentinel-hub.com/api/latest/data/sentinel-2-l2a/.
2. ESA (2025) Additional request parameters, Sentinel Hub. Available at: https://docs.sentinel-hub.com/api/latest/api/ogc/additional-request-parameters/#atmospheric-correction.
3. McFeeters, S.K., 1996. The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. *International journal of remote sensing*, *17*(7), pp.1425-1432.