**Great Slave Lake Water Resources**

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

**Project Team**

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**Project Overview**

***Project Synopsis:***

Long-term changes in water levels within the Slave River Delta threaten important transportation routes, fishing resources, and delta ecosystems. Building upon existing field-based water-monitoring efforts by partners at the Fort Resolution Métis Government, the Deninu K’ue First Nation, the Akaitcho Territory Government, and Environment and Climate Change Canada, this project leveraged satellite data on surface water, land cover, precipitation, and water levels from 1984 to 2021 to illustrate and help explain long-term changes in the delta through time series visualizations and analyses.

***Abstract:***

Indigenous communities around the Great Slave Lake (GSL) in Canada’s Northwest Territories have observed long-term changes in water levels within the Slave River Delta (SRD), causing concern over the alteration and loss of natural and cultural resources. Changes in delta water dynamics have impeded fishing and transportation accessibility and threatened to alter important wetland ecosystems, leading to greater uncertainty in natural resources management. In partnership with the Fort Resolution Métis Government (FRMG), the Deninu K'ue First Nation (DKFN), the Akaitcho Territory Government (ATG), and Environment and Climate Change Canada (ECCC), this project provided a visual archive of water patterns and land cover in the Slave River Delta for summer months (May to October) from 1984 to 2021. We produced time series animations, maps, and charts of land cover and delta morphology changes using data from NASA's Landsat 5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) missions, augmented with other NASA-supported satellite imagery, land cover classifications, and precipitation datasets. Satellite observations confirm that changes in surface water and wetland extent in the delta tend to correlate with changes in Slave River discharge and precipitation in the drainage basin. However, we identified several water channels in the Slave River Delta and several areas of former wetland whose drying trends have persisted despite increases in precipitation and discharge from 2010 to 2020. By synthesizing various Earth observations into understandable and accessible data visualizations, the project strengthened decision-makers' overall understanding of drivers of change in the Slave River Delta.

***Key Terms:***

Great Slave Lake, Northwest Territories, wetlands, land cover, delta, remote sensing, water dynamics, NASA Earth observations

***National Application Area Addressed:*** Water Resources

***Study Location:*** Slave River Delta, Northwest Territories, Canada

***Study Period:*** 1984 –2021 (June – October)

***Community Concerns:***

* Reduced water levels in channels of the Slave River Delta can inhibit the ability of boats to travel within the delta, affecting local communities’ fishing and transportation activities.
* Changes in water dynamics may affect the distribution of wetland habitat for local animals, some of which constitute important sources of food and carry cultural importance for local Indigenous communities.
* Uncertainty about the primary drivers of environmental change in the delta and the timescales on which they occur impedes efforts to effectively plan future land and water management projects.

***Project Objectives:***

* Map long-term trends in the spatial extent of surface water within the Slave River Delta, focusing on the widening or narrowing of distributary channels
* Analyze changes in Slave River Delta surface water extent and Great Slave Lake water levels in relation to changes in cumulative precipitation within the Slave River watershed
* Perform land cover classification of the Slave River Delta in order to quantify historical changes in the spatial extent of wetland habitats within the delta
* Produce widely-accessible research products that enable community members to effectively participate in regional decision-making processes surrounding water resource protections

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Fort Resolution Métis Government** | Shawn McKay, Environment Coordinator | End User | Yes |
| **Deninu K’ue First Nation, Aquatics Division and Lands Division** | Kathleen Fordy, DKFN Aquatics Coordinator; Minnie Whimp, DKFN Lands Coordinator | End User | Yes |
| **Aboriginal Aquatic Resource & Oceans Management (AAROM), Akaitcho Territory Government** | Diane Giroux, AAROM Coordinator; Mike Tollis, Technical Advisor | End User | No |
| **Environment and Climate Change Canada, Water Science and Technology Directorate** | Marlene Evans, Research Scientist | Collaborator | No |

***Decision-Making Practices & Policies:***

Our partners have led community-driven field observation efforts to sample water chemistry and assess fish populations in response to water quality concerns in the Slave River Delta. Our partners also monitor nearby weather stations and river gauges for more general weather, climate, and water flow measurements, but their efforts to monitor and manage water resources currently do not incorporate satellite-based remote sensing. Our Indigenous government partners plan to use our findings to inform their contributions to local decision-making processes as well as their ongoing community education and environmental advocacy efforts. Environment and Climate Change Canada, meanwhile, uses the information it collects to implement environmental policies and programs across Canada, including the delta region.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Reflectance | We used reflectance from all multispectral bands for land cover classification and time series imagery. |
| **Landsat 7 ETM+** | Reflectance | We used reflectance from the RGB bands for the year 2000 as part of our time series imagery. |
| **Landsat 8 OLI** | Reflectance | We used reflectance from all multispectral bands for land cover classification and time series imagery. |
| **TOPEX/Poseidon** | Water levels | Mean water levels of Great Slave Lake were correlated with ancillary datasets on surface water extent in the delta and watershed precipitation. |
| **Jason-1**  **Jason-2**  **Jason-3** | Water levels | Mean water levels of Great Slave Lake were correlated with ancillary datasets on surface water extent in the delta and watershed precipitation. |

***Ancillary Datasets:***

* Joint Research Center (JRC) Global Surface Water – Water extent data for investigating evolution of the delta and transportation in channels
* NASA Arctic-Boreal Vulnerability Experiment (ABoVE): Wetland Type, Slave River and Peace-Athabasca Deltas, Canada, 2007 and 2017 – Land cover classification map for training and validating time series classification maps using based on Landsat and Sentinel imagery
* NASA/United States Department of Agriculture (USDA) Global Reservoir and Lake Monitor (G-REALM) – Time series of relative GSL surface water elevations for analyzing lake water levels
* NASA Daymet dataset - Precipitation data for investigating the change of annual total precipitation in basin areas
* Canadian Digital Elevation Model (CDEM) – DEM data for generating watershed boundaries
* United States Geological Survey (USGS) Global multi-resolution terrain elevation data 2010 (GMTED2010) – DEM data for generating watershed boundaries
* Water Survey of Canada (WSC) Watersheds in Canada – Watersheds shapefile for Great Slave Lake region

***Software & Scripting:***

* Google Earth Engine API – Accessing and processing satellite data, time series animations, land cover classifications, data exporting
* QGIS 3.10.8 – Watershed delineation
* GDAL 3.1.2 – Watershed delineation
* Esri ArcGIS Pro 2.9.3 – Land cover map production
* Python 3.9.10 – Land cover change map production
* RStudio 1.4.1717 (R 4.1.2) - Statistics and creating plots
* Microsoft Excel 2016 16.0.5332.1000 - Creating plots and tables

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Delta Land Cover Maps** | Landsat 5 TM  Landsat 8 OLI | Maps of land cover over time will help partners understand how changing water levels and dynamics are affecting the ecosystems in the delta region. | N/A |
| **Delta Morphology Time Series** | Landsat 5 TM  Landsat 7 ETM+  Landsat 8 OLI | Animated maps, change images, and charts of delta evolution will help the partners understand how the structure of different parts of the delta have changed over time. | N/A |
| **Precipitation, Discharge, and Water Level Time Series** | TOPEX/Poseidon  Jason-1  Jason-2  Jason-3 | Charts of annual watershed precipitation, Slave River flow, and GSL water levels will help partners understand drivers of change in delta water resources. | N/A |

***Product Benefit to End User:***

By providing a comprehensive time series of changes in Slave River Delta channel morphology and land cover in relation to precipitation and water levels, we aim to assist policy-makers and environmental decision-makers in making informed land and water management decisions. The analytical results generated by our research products could inform muskrat habitat restoration plans, water monitoring campaigns, and water transportation planning efforts. Our visualizations of environmental change can also provide an effective means of engaging local communities in bottom-up efforts to address environmental issues and protect regional water resources.

**References**

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