# UPDATING CHS CHARTS WITH REMOTE SENSING DATA- A RADAR AND OPTICAL APPROACH

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Introduction

The goal of this project is to produce up-to-date shoreline using remote sensing data with an accuracy of **5 m with a 90% level of confidence**. The Mackenzie River was selected as the study site since it is one of the most dynamic water systems in Canada. Areas of changes are also identified for the collection of new survey data.

Study Site
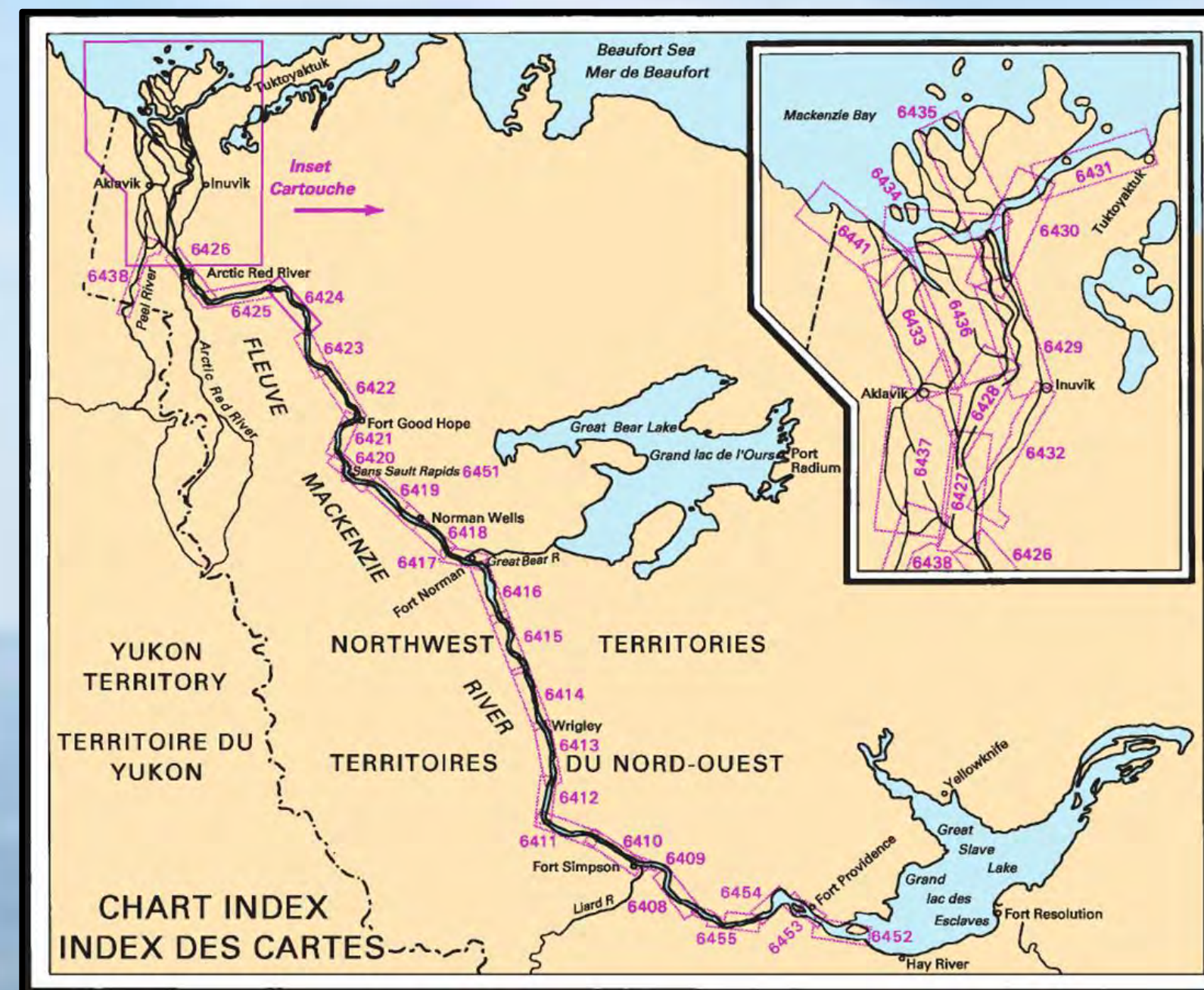
The Mackenzie River is the longest river in Canada covering a distance of 1800 km. 37 charts at a 1:50 000 scale are needed to cover the Mackenzie River and delta.
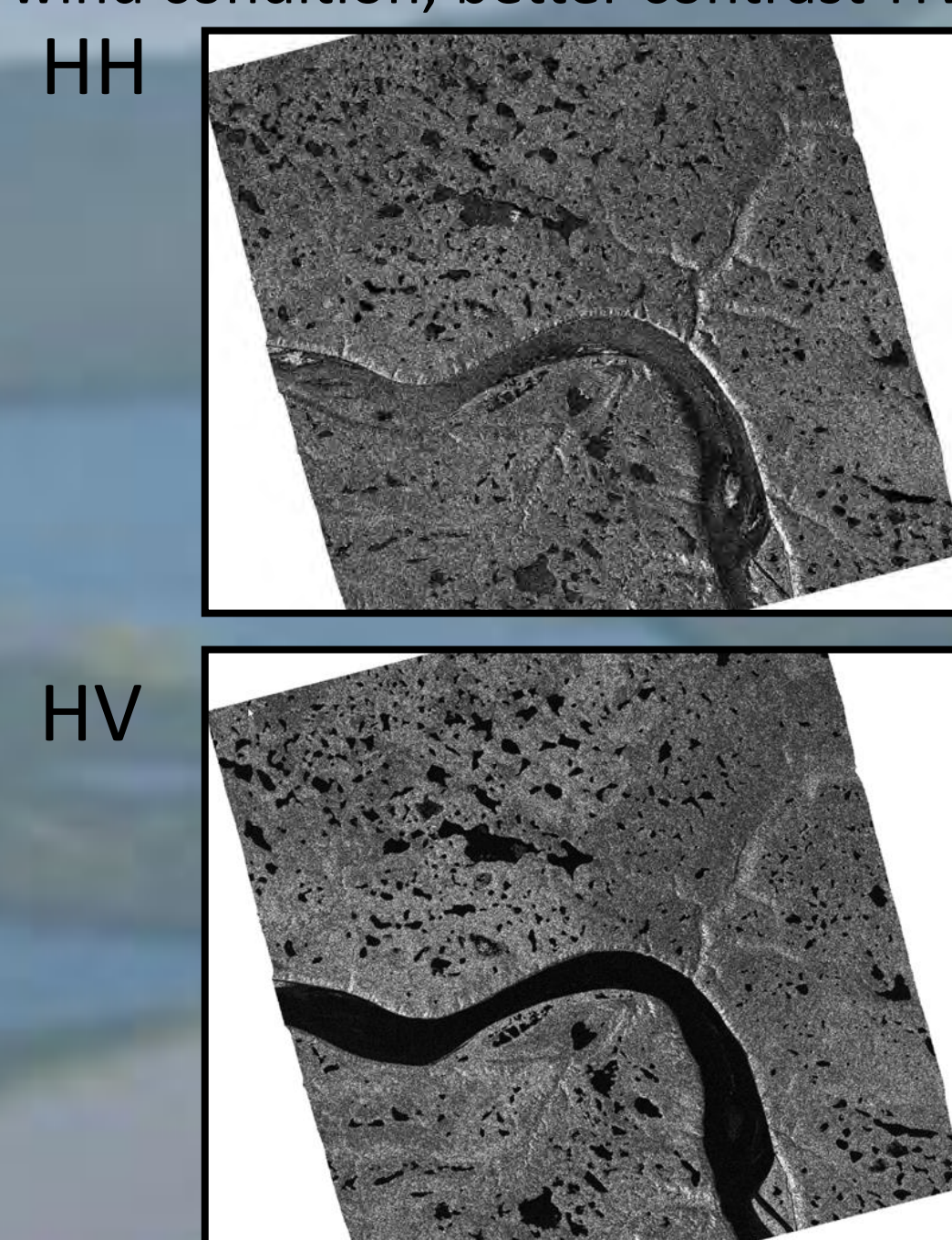

Data

Radar: Radarsat-2 Dual-polarization (co-polarization **HH** , cross-polarization **HV**) is used to have a better contrast between water and land in different wind conditions. Wide Fine mode images with a 6 m resolution and 150 km swath were used for this project.

Low wind condition, better contrast-HH

HH
HV
HH and HV
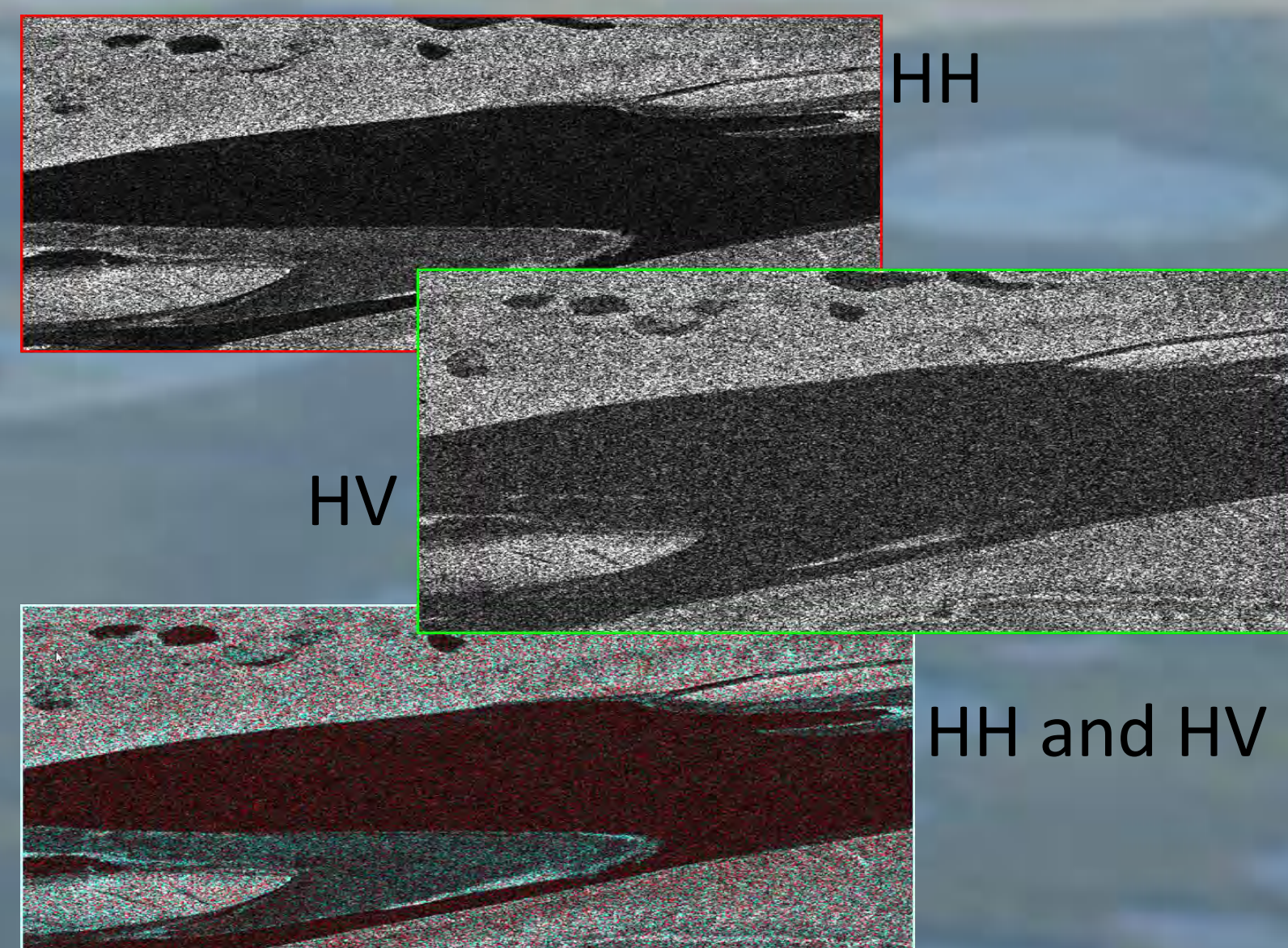
High wind condition, better contrast-HV

HH
HV

Optical: Landsat 8 OLI

Landsat 8 Operational Land Imager (OLI) sensor
Bands used: Multispectral bands
1-7,9: 30-meters resolution
Panchromatic band
8: 15-meters resolution
Used for image interpretation and image classification

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3D Physical Model

Radarsat-2: To achieve an accuracy of 5 m, Radarsat-2 data were geometrically corrected using a 3-D Physical Model (Toutin, T., Chenier, R., 2009. 3-D Radargrammetric Modeling of RADARSAT-2 Ultrafine Mode: Preliminary Results of the Geometric Calibration. IEEE Geoscience and Remote Sensing Letters, 6 (3).)

Landsat-8: USGS, Standard Terrain Correction (Level 1T) data were acquired. The Level 1T data were geometrically corrected with ground control points and a Digital Elevation Model (DEM) for topographic accuracy. Geodetic accuracy of the product depends on the accuracy of the ground control points and the DEM used. The Landsat data accuracy within the study site are around 30-60 m.

Validation Data

Relative accuracy: By overlapping two Radarsat-2 ortho-images from different dates of acquisition, we have one pixel accuracy (5 m pixels).

15 Oct 2012
22 Oct 2012

Absolute Accuracy: The Radarsat-2 ortho-images were compared with Natural Resources Canada (NRCan) CanVec Data, scale 1:50 000. Since these data don't have a precision of 5 m, the true accuracy of the ortho-images cannot be evaluated with the CanVec. We can only confirm that we do not have large errors.
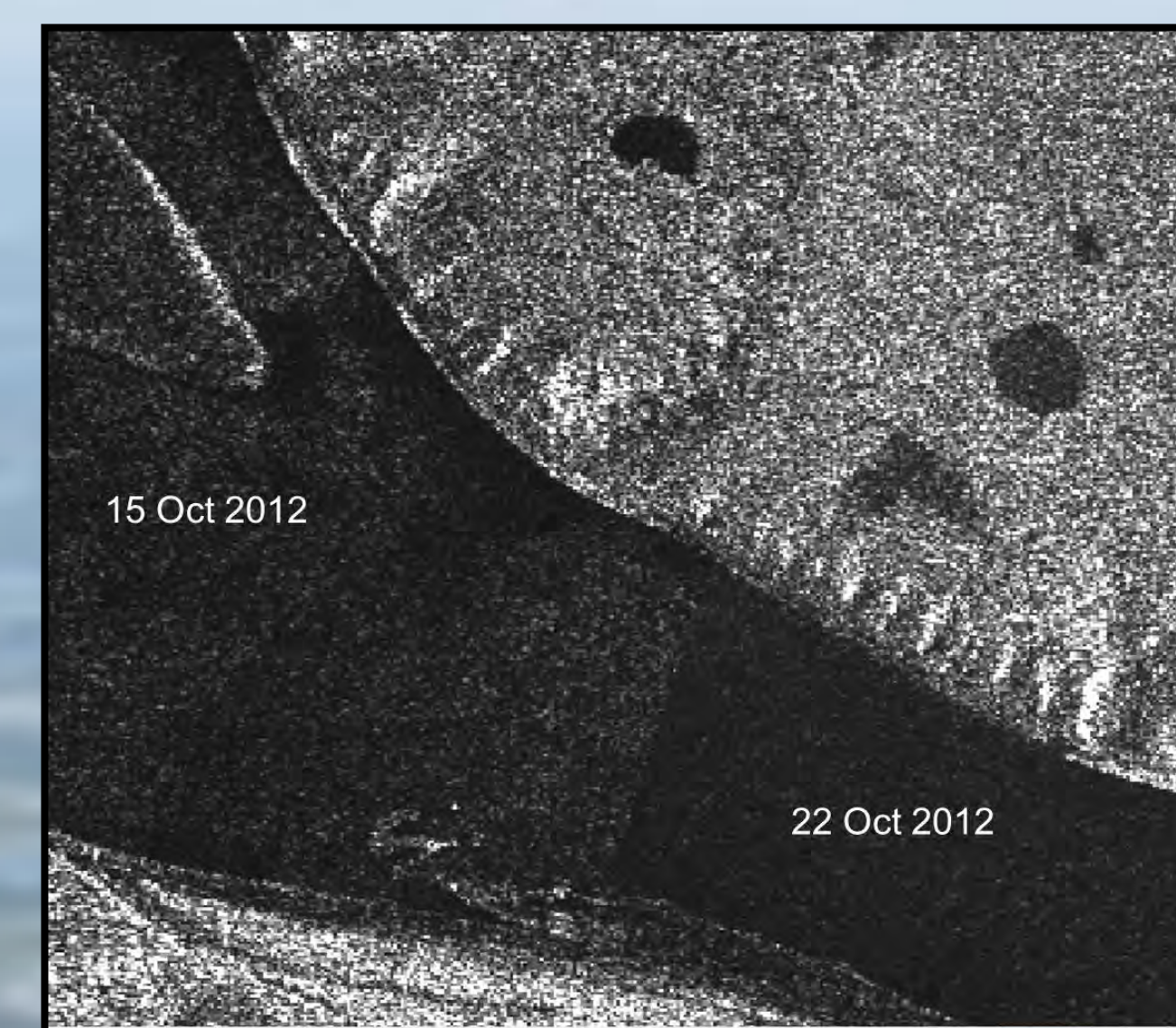
Temporal Variations
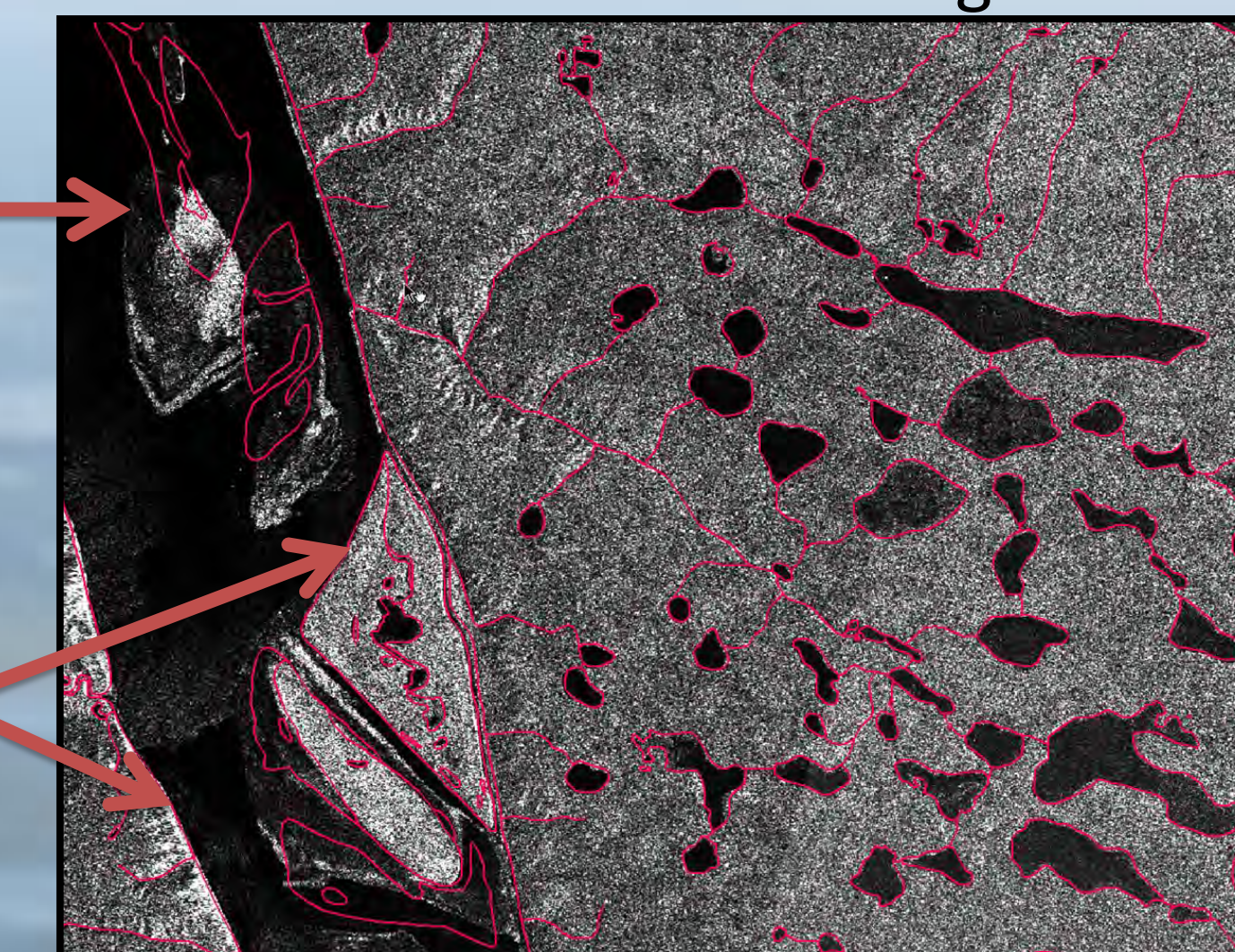
Good positioning Accuracy

Acquisition Dates

The Radartsat-2 images were acquired during the low water month (**October**).

Landsat-8 images were used for the interpretation and classification. Since It is very difficult to get cloud free images in September or October, images are acquired in **August** to get a mean water level. Historical data (Landsat data from 1973-2013) were also used to understand the evolution and rate of change within the Mackenzie River system.
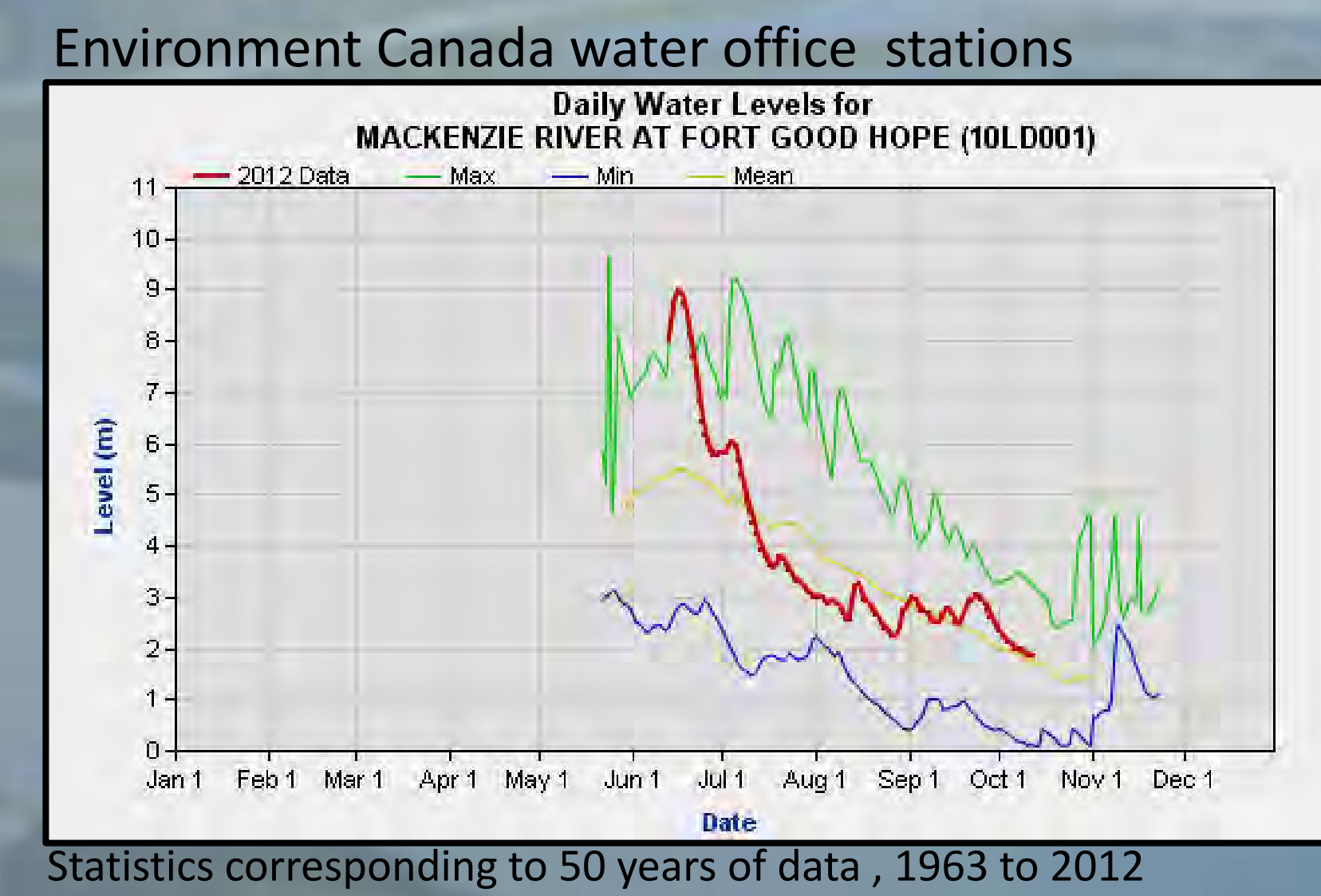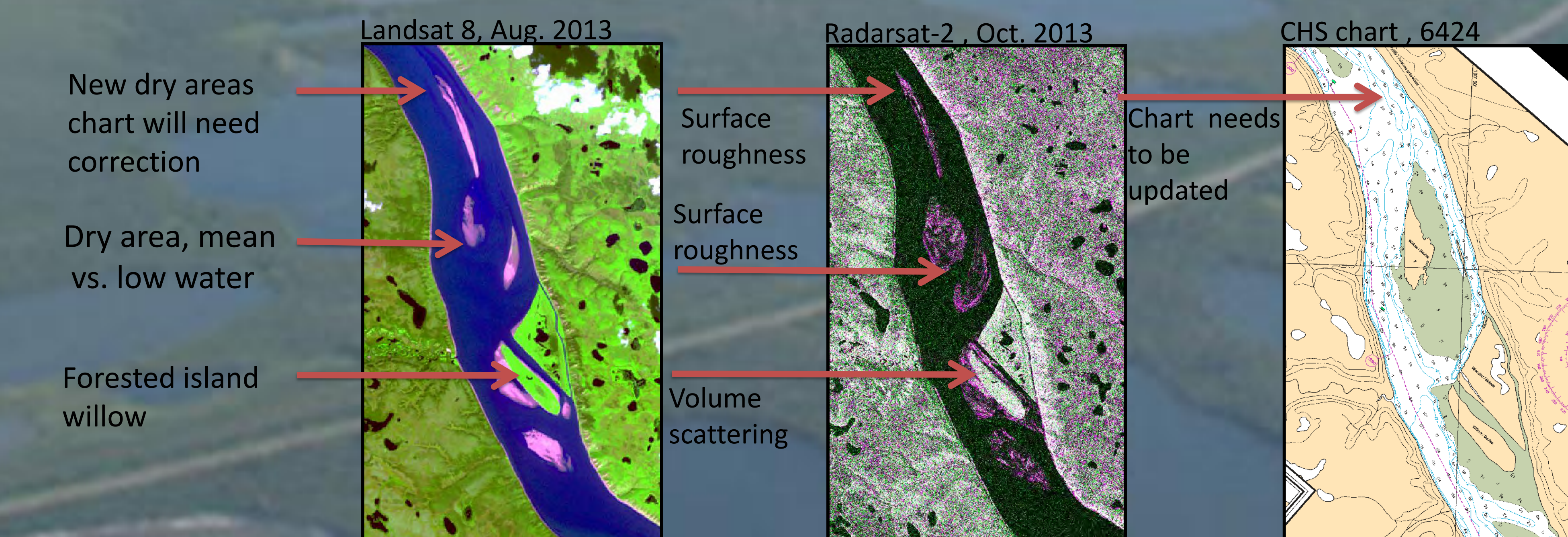
Environment Canada water office stations

Daily Water Levels for
MACKENZIE RIVER AT FORT GOOD HOPE (10LD001)

Statistics corresponding to 50 years of data , 1963 to 2012

Image Interpretation

Together, optical and Radar imagery can help in the image interpretation and change detection classification.

Landsat 8, Aug. 2013
Radarsat-2 , Oct. 2013
CHS chart , 6424

New dry areas chart will need correction

Dry area, mean vs. low water

Forested island willow

Surface roughness

Surface roughness

Volume scattering

Chart needs to be updated

Land Cover Classification and Segmentation

1-An image supervised classification from Radarsat-2 and Landsat data is used to create three classes: Land, water and drying areas.

1-Image classification
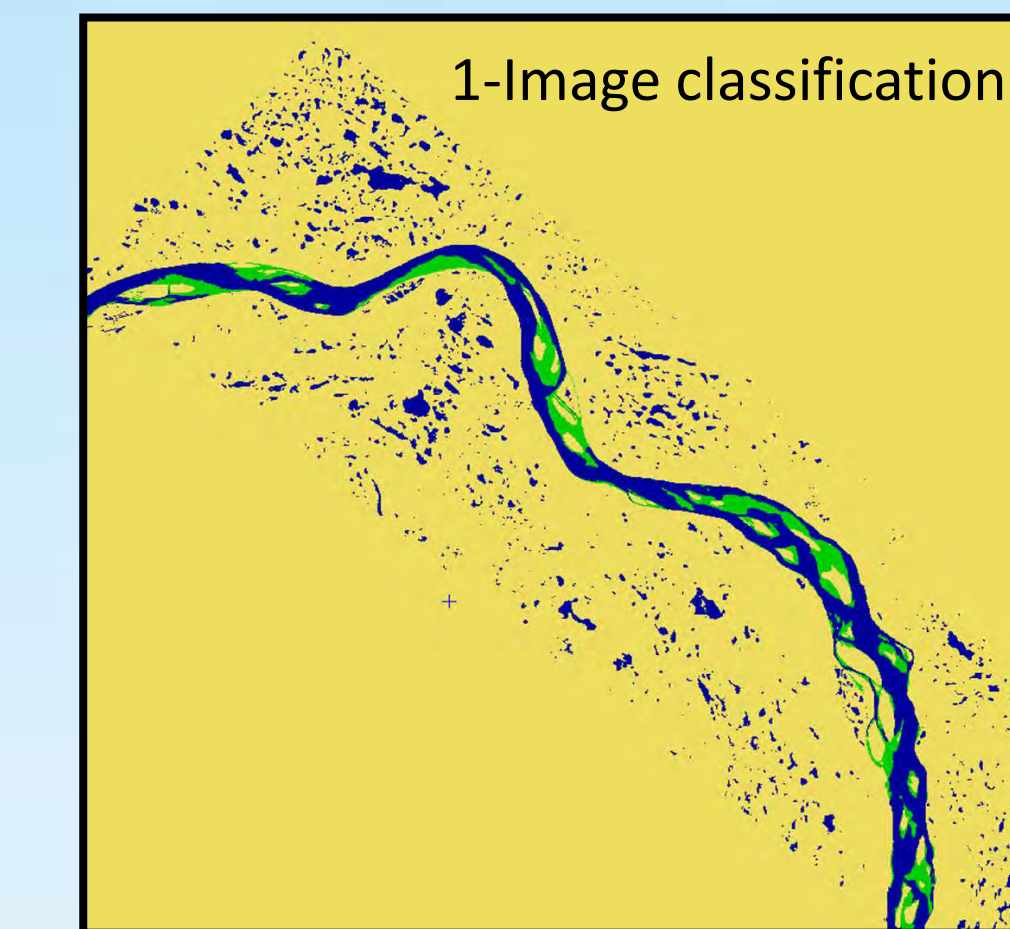
2-The Classification is segmented to produce the vectors that will be used to update the Chart.
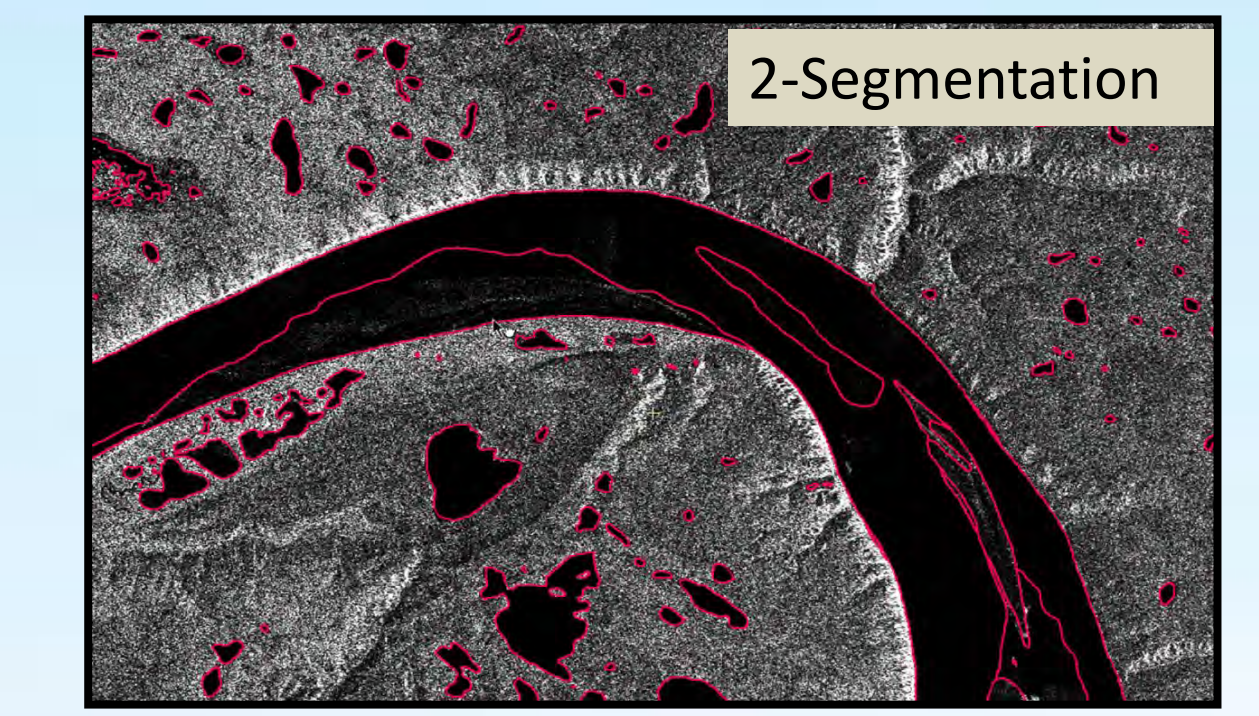
2-Segmentation

Chart Updating

The remote sensing vector of the shoreline is used to update the chart. The Chart is reconstructed in Caris HPD and coded in S-57 format. The advantage of having all objects in vector is that the charts will be easy to keep up-to-date. Updating the charts with new shoreline can have an important impact on the bathymetry. With the formation of new islands or erosion on the river, new survey data will be needed to correct the chart.
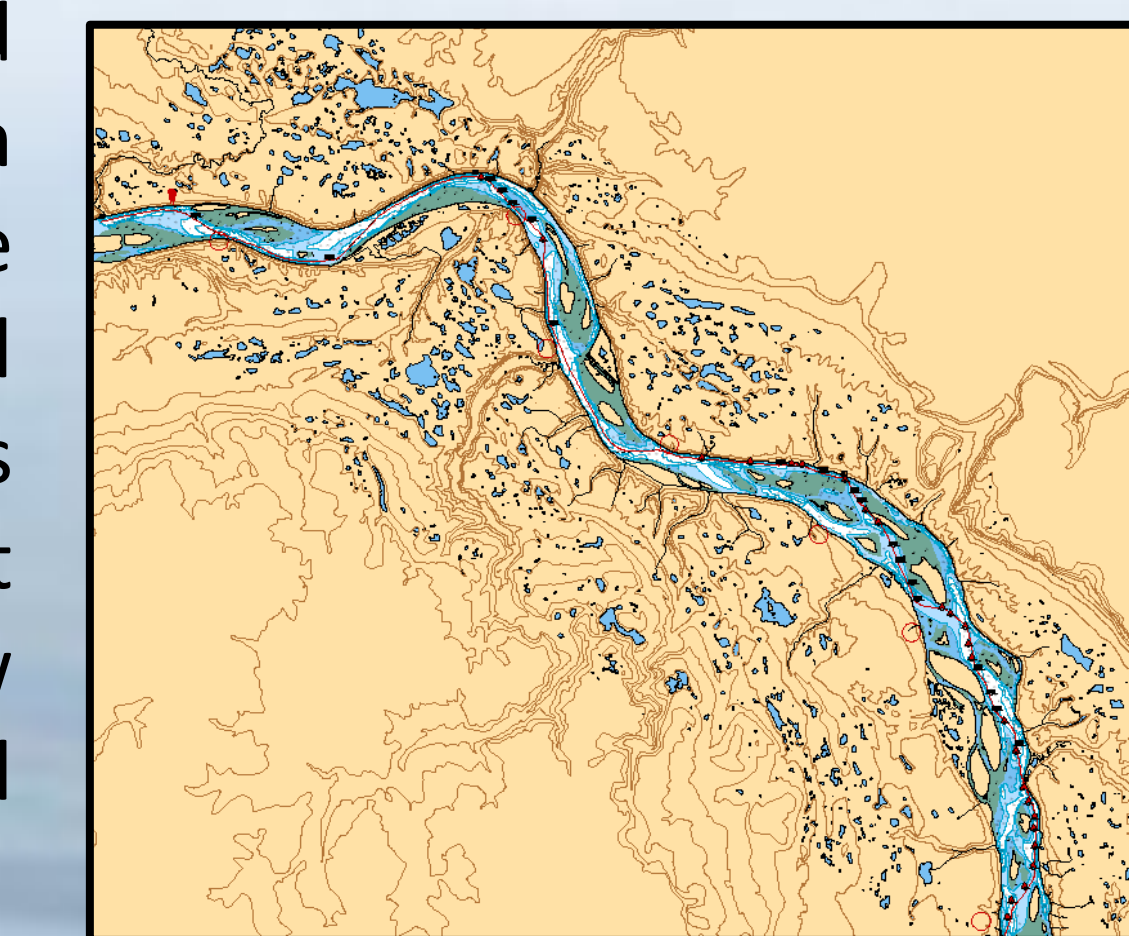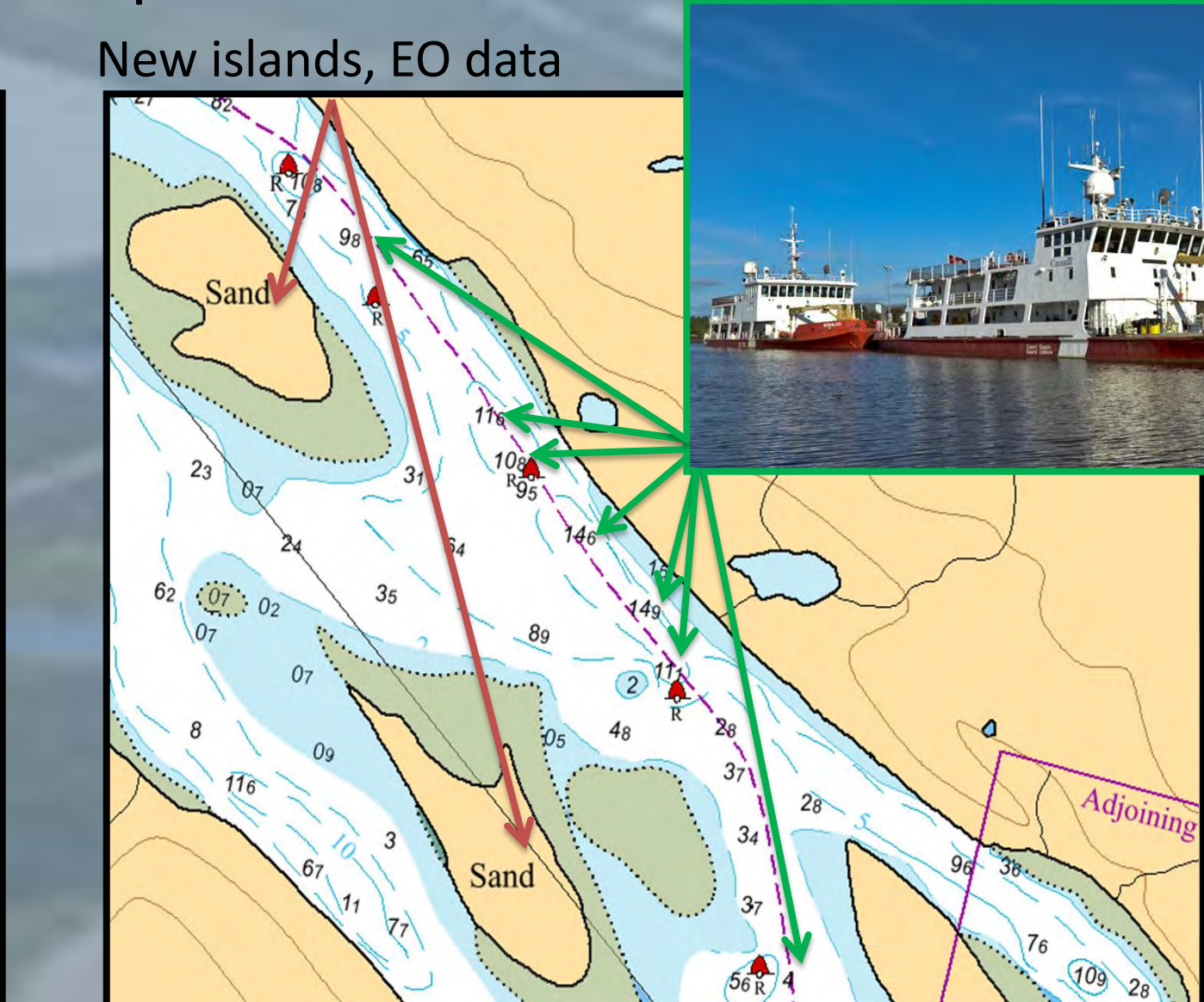

New Survey

CHS is currently working on a pilot project with Canadian Coast Guard (CCG) in Hay River. The project proposes to have new soundings collected in areas defined with the remote sensing approach.

Current edition Chart 6424

Updated chart 6424

New islands, EO data

New soundings (CCG)
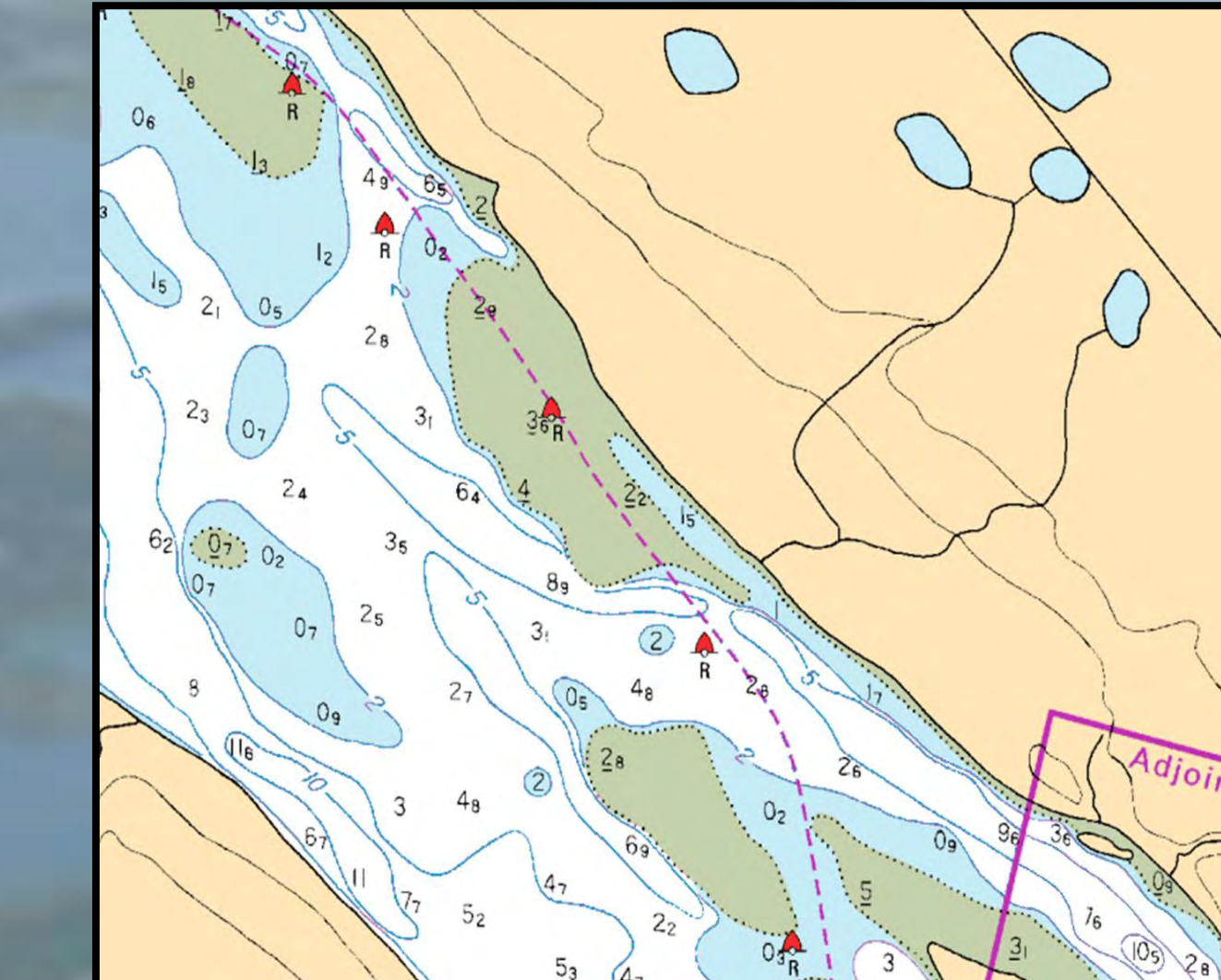
Conclusion

The main goal of this approach is to produce accurate shoreline anywhere in Canada and identify areas of change for the acquisition of new survey data. Change detection with historical data was also used to evaluate the frequency at which the shoreline should be updated. For chart 6424, 40 years (1973-2013) of Landsat data were used to evaluate the rate of changes of the river. Large portions of the river covered by chart 6424 are very dynamic, therefore change detection for chart 6424, should be done almost every year. This approach could be used to update charts in other remote areas of the country, especially in the Arctic. In the context of this study, the advantage of the Landsat-8 new coastal band was not utilized since the Mackenzie River has large volumes of sediment, which prevents the light from penetrating the water column. In areas of clear water, Landsat-8 imagery could also be used to identify new shoal areas.

Canada