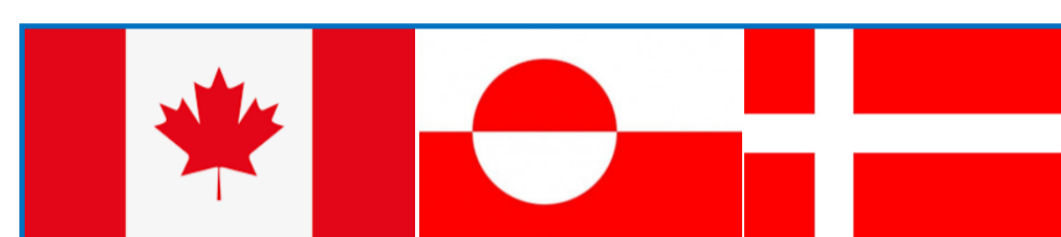


On 2021-11-26 after 5 days of marathon negotiations in Reykjavik, a joint task force consisting of lawyers/diplomats and geodetic/technical advisors from the Kingdom of Denmark and Canada agreed on the division of Tartupaluk (Hans Island) and the division of a seabed area in the Labrador Sea (overlapping claims on the continental shelf). The old dividing line from 1973/2012 has also been reviewed and quality assured. A

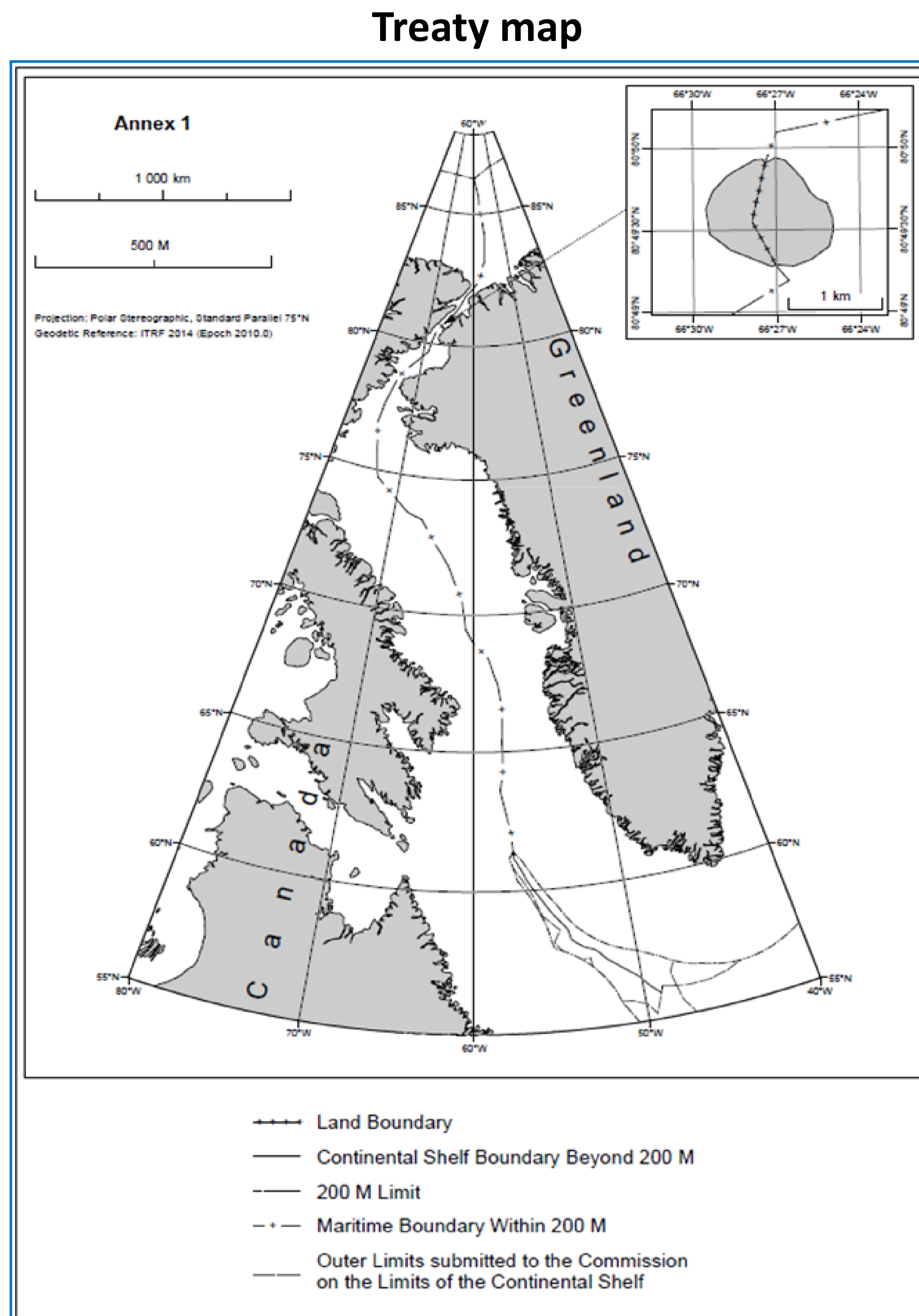
A total delineation of 3962 km and KoD has now got a new land boundary at Tartupaluk, - the only one apart from the old land border between Denmark and Germany from 1920 at the end of World War I.

As geodetic/technical advisor to the Danish Ministry of Foreign Affairs and in corporation with GEUS (Geological Survey of Denmark and Greenland), DTU Space, GST (The Danish Geodata Agency) and the Canadian authorities, The Danish Agency for Data Supply and Infrastructure (SDFI) has played a leading role in the technical work.

As a result of an exemplary and fruitful Cooperation the treaty was signed in June 2022 at a ceremony in Ottawa.



Worlds longest maritime border delimitation and a new landborder!



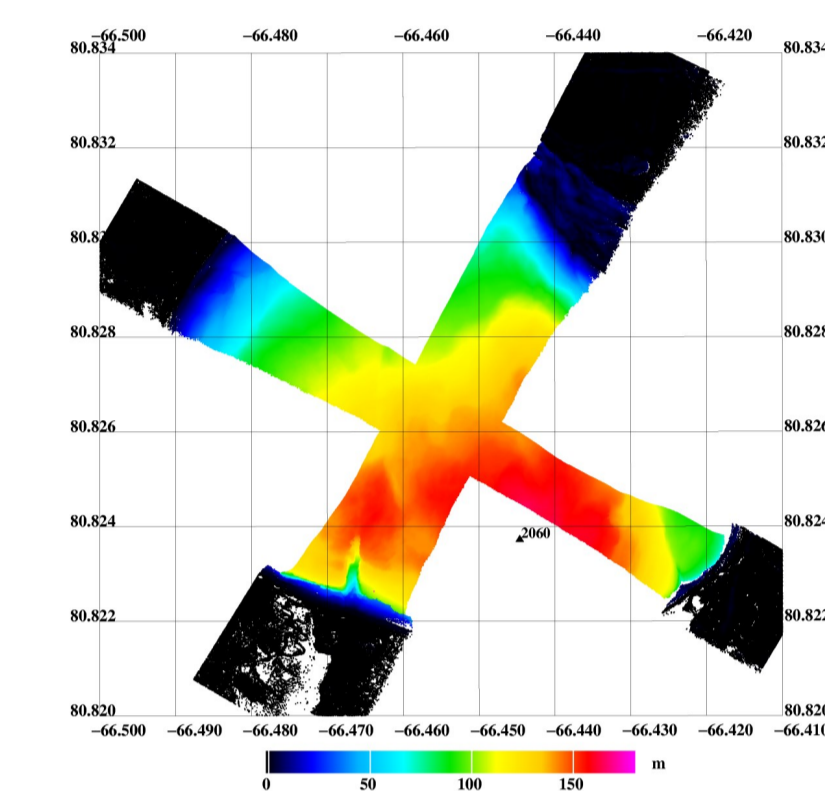
Delimitation on Tartupaluk.

Land boundary delimitation demands much higher precision of the achieved coordinates than maritime boundary delimitation. Very often it is desirable that the new boundary follows natural and visible features in the landscape.

During the early diplomatic correspondances between KoD and Canada a common desire to follow the natural north south directed ravine on Tartupaluk was expressed.

At an early stage the Joint Technical Taskforce realized that better data and an absolute orientation of the data was needed. To set foot on the island and having "ground control" was at this point not possible.

Therefor a new World View 2 satellite image was purchased and georeferenced using a DEM derived from 2004 LiDAR data. A good example of how older data collected for one purpose can be brought to life and bring important value in a different context.

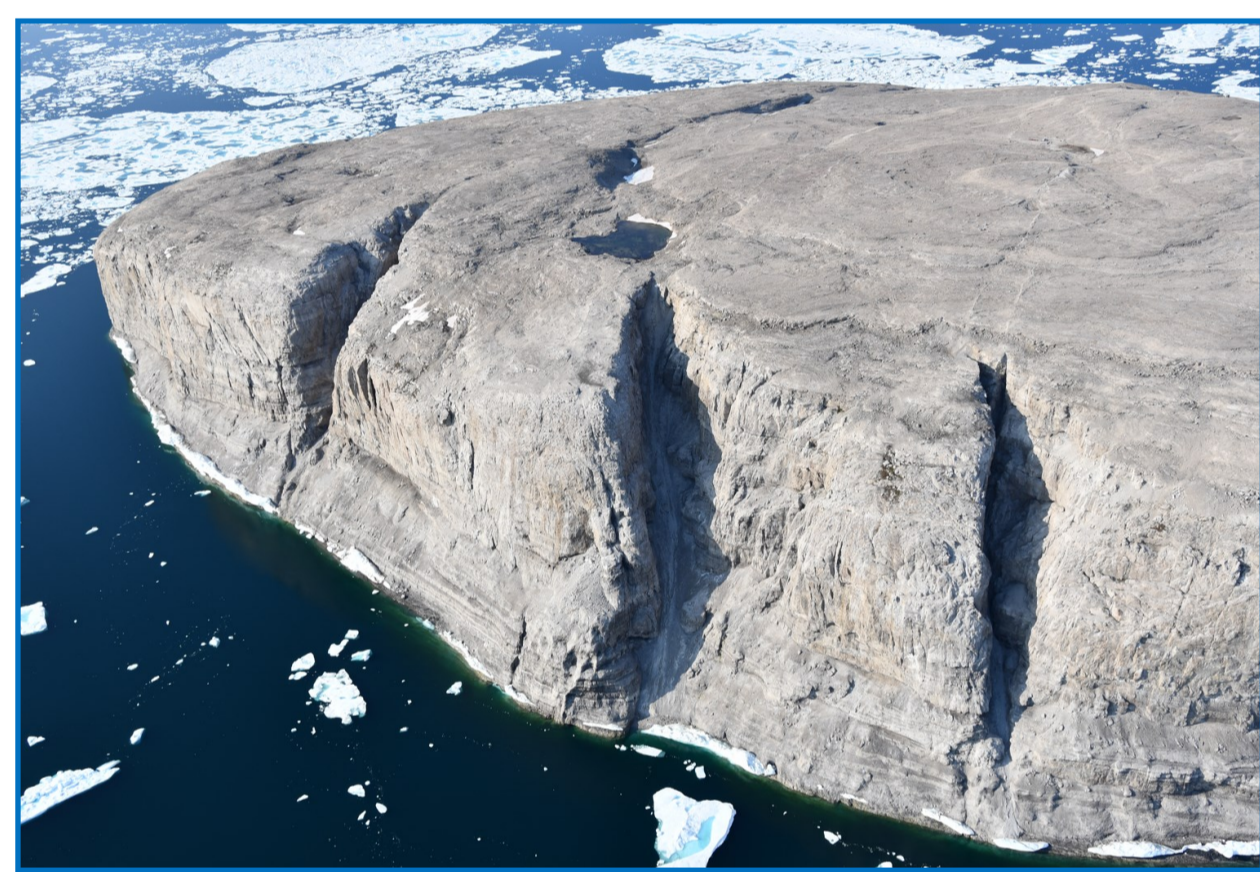


Digital elevation model (DEM) partly covering Tartupaluk.

Bringing new value to old data

The technical taskforce soon discovered that the absolute orientation of the provided high resolution satellite image of Tartupaluk was quite poor. Comparing it to some old photogrammetry data collected in the 1980s implied discrepancy. The "truth" was found by fitting the satellite image to a LiDAR data derived DEM.

In May 2004 an airborne LiDAR campaign was carried out by the Geodynamics Dept. of KMS (National Survey and Cadaster, Denmark). The Campaign had several purposes but the primary aim of the survey was to collect sea ice freeboard heights. On an opportunity basis the LiDAR dataset also provided elevations across two cross-sections of Tartupaluk. A bit by chance and because of good corporation and connections in the geodetic community the old LiDAR data along with a new satellite image formed the basic data for the rest of the delimitation on Tartupaluk.



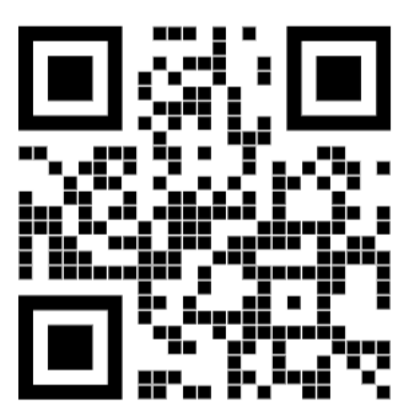
Tartupaluk view from South East

Tartupaluk is a small uninhabited island of app. 1.2 km² situated in the narrow Kennedy Strait between Canada and Greenland.

To the south the rock rises abruptly from sealevel to app. 168 meters. To the north it flattens gradually out and disappears below sealevel. It has a more or less continuously N-S directed ravine.

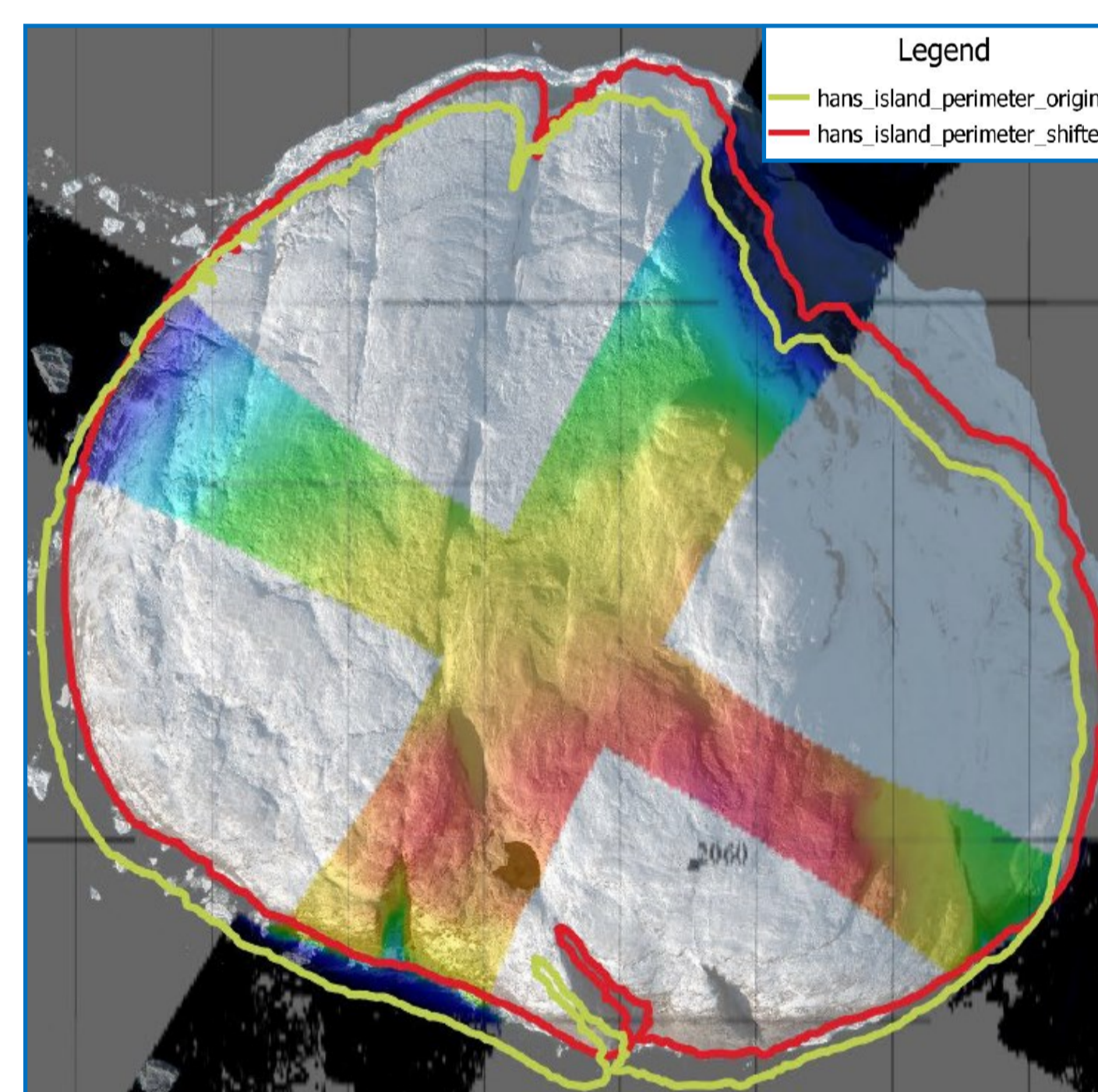


Video: Around Tartupaluk

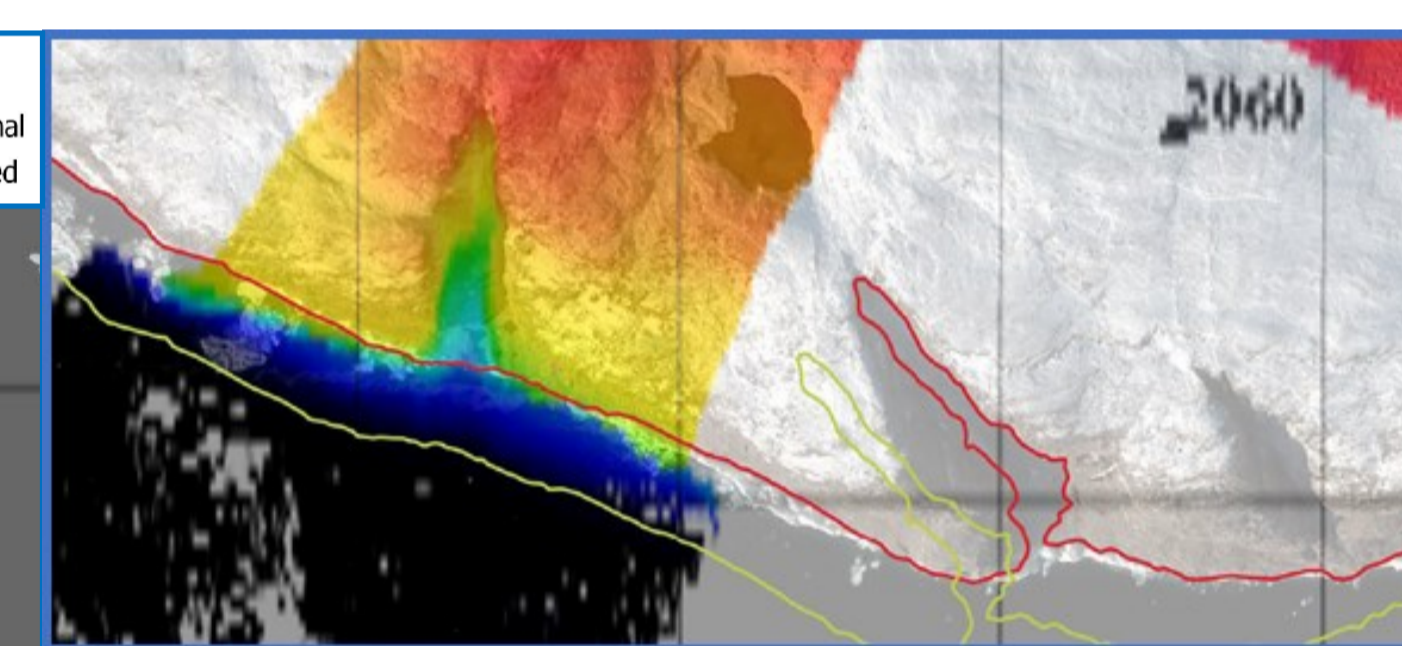


Video: Flythrough gully

The Inuit name Tartupaluk refers to its shape of a human kidney.

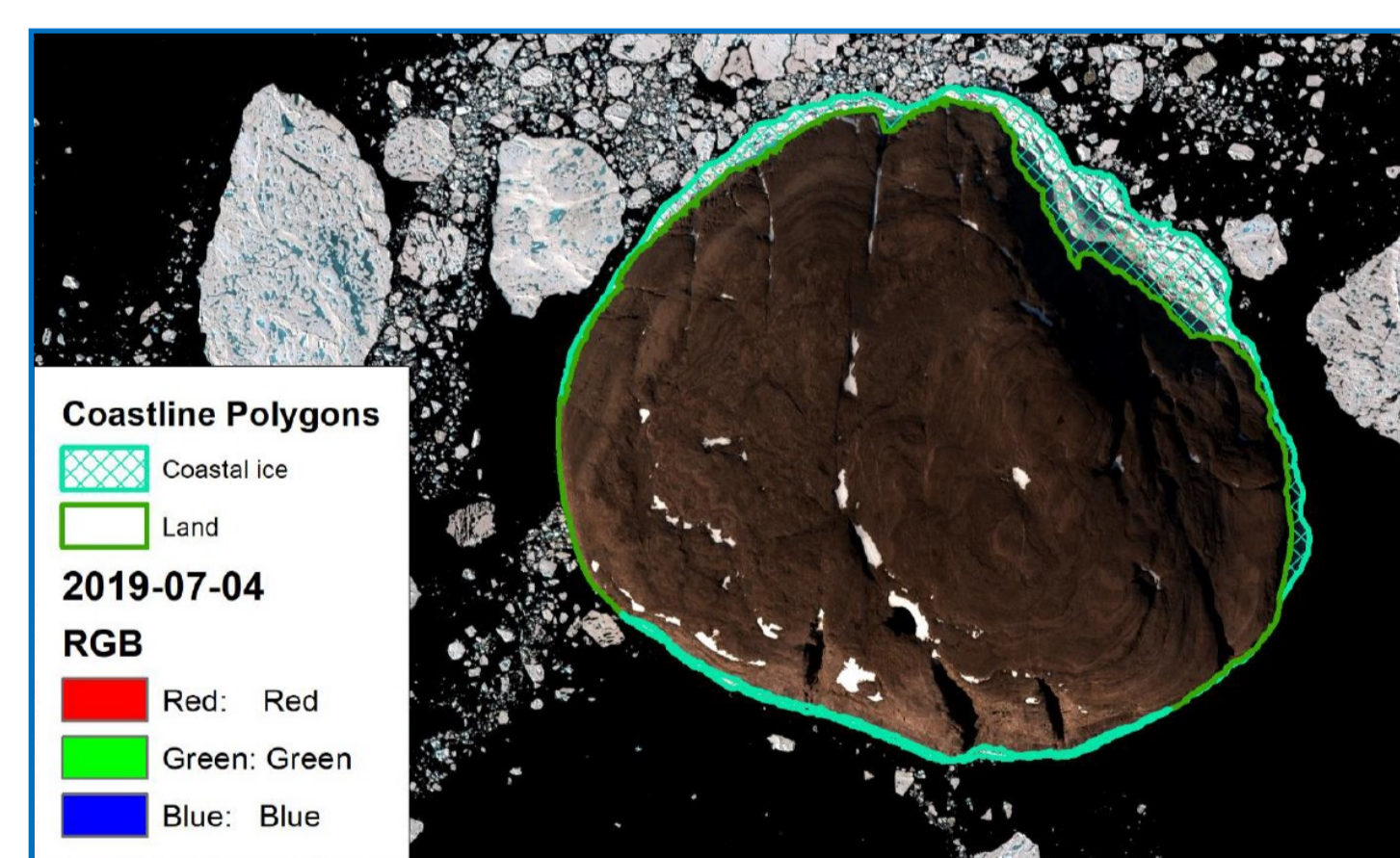


Mismatch between LiDAR data and original satellite image



The first Satellite image:
A horizontal shift in the N-NE direction of approximately 50 meters on top of the rock. Less at sea level.
The higher the the more because of poor or none orthorectification.

The 2004 LiDAR overflights of Tartupaluk were made on an opportunity basis in connection with the DTU/ESA CryoVEx campaign 2004, enroute from Thule Air Base to CFS Alert. The DTU LiDAR system, mounted in an Air Greenland Twin-Otter, provided an absolute positioning accuracy of 1 m or better, and absolute accuracy of 50 cm, mainly limited by uncertainty in the geoid height. The relative vertical accuracy of the used Riegl laser scanner/GPS vertical positioning is around 5-10 cm.

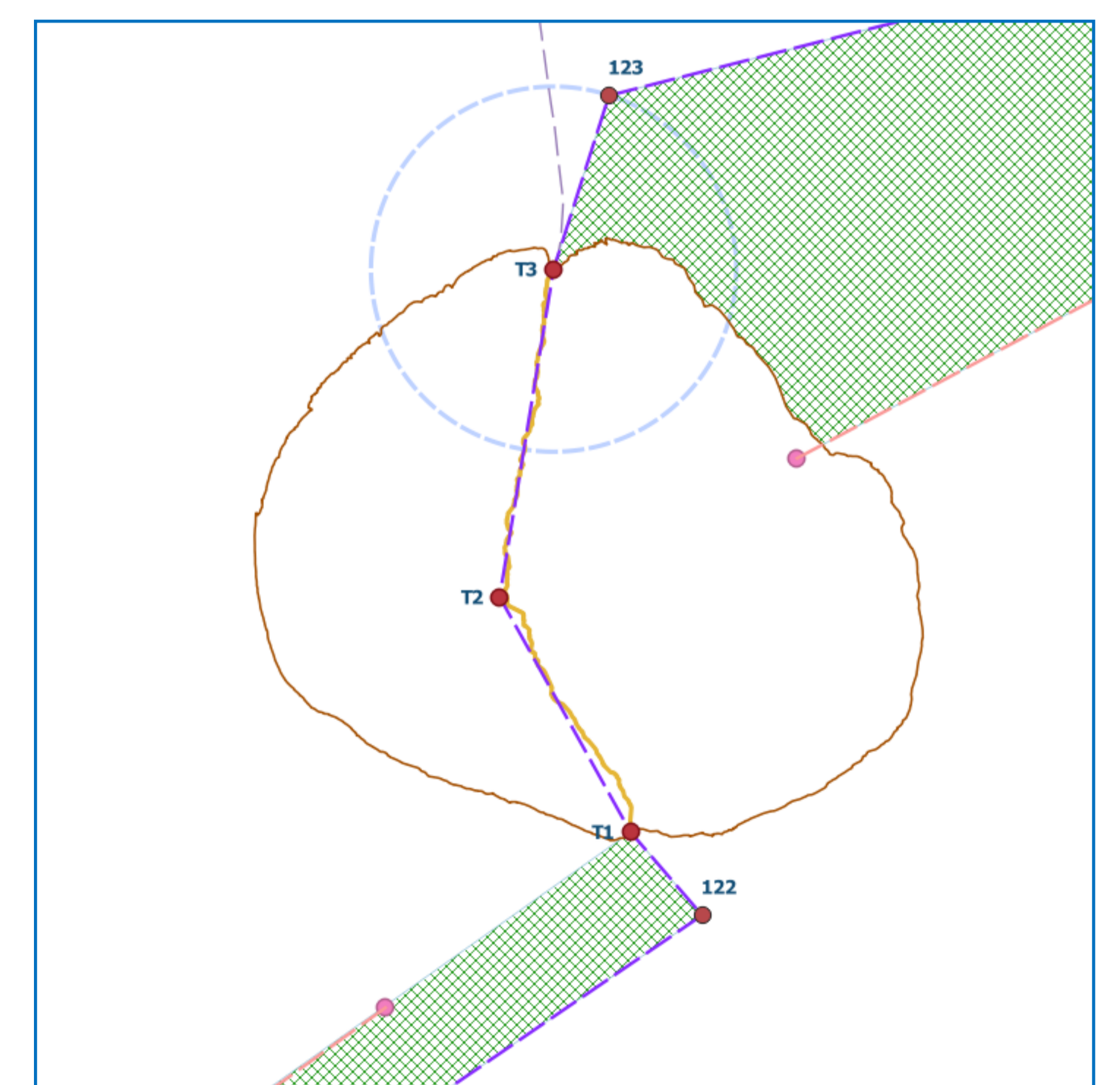
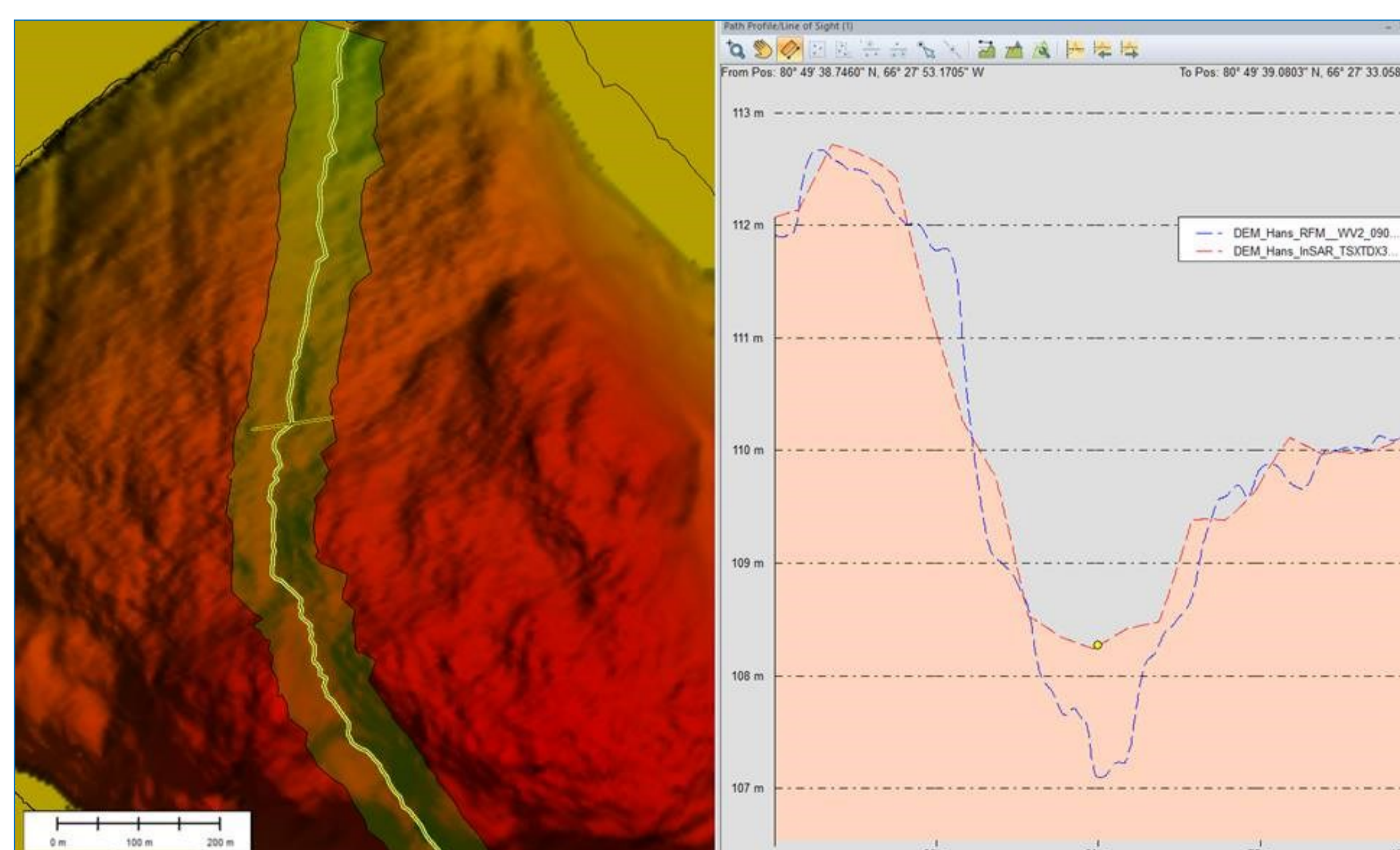


New image from DHI Grass and digitized coastline. The WV-2 imagery was acquired on 2019-07-04. View angle of -0,6 degree, off-nadir angle of 1,5 degree. Sun elevation angle 29,1 degree, azimuth angle of 228,9.

Assessment:
With the new basic data, digitizing better than 5 meters on Tartupaluk in the absolute position is realistic.
All treaty coordinates are rounded to 0.1 degree (app. 2 m)

- DEMs used in the process
- DTU DEM(Lidar). Only partial coverage.
 - WV DEM within 0.5 meter local orientation. Full coverage.
 - TREx within 10 meters absolute orientation. Full coverage. Used as backing control

Finding the lowest point of the gully cross sections I GIS. Pouring on water, flow of the water. Surface runoff model.



- Examples of calculations on the basic data:
- New coastlines. Dark ice. Multiple scenarios
 - Delimitation line. Ratio calculations. Multiple scenarios
 - Number of vertices of the new line. Multiple scenarios
 - Offshore adjustment, new points 122 and 123 of the tentative 2012 agreement. Equal areas or minimum areas
 - Main drainage outlet of the gully. Determining terminus.
 - Buffer zone for vessels entering from the north.
 - Equidistance line calculations in the small northern bay.