Mapping Coastal Areas is Important for Safe Navigation in the Arctic

As critical buffer zones between land and ocean, coastlines are highly dynamic and susceptible to change. However, earth observations provide a possible means to monitor and map coastal zones.

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The challenge

Detailed and up-to-date knowledge about the extent of coastlines, their dynamics and the location of submerged rocks and shallow water areas is critical for safe navigation.

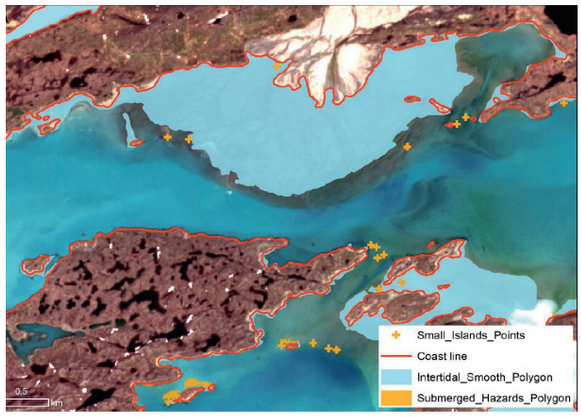
Detecting coastlines and rocks has significant importance for navigation. It inherently depends on precise and up-to-date knowledge on coastline extent and dynamics and information on location of rocks.

The coastline in nautical charts has to be in a detailed quality, in which it is possible to overlay the real coastline detected by onboard radar, ensuring mariners' confidence in the electronic chart.

The space-based solution

The new generation of high-resolution and freely available satellite data offered by the Sentinel missions has propelled the potential for automated and consistent monitoring approaches for shoreline detection and mapping of marine hazards.

In a pilot project undertaken by DHI GRAS in South-East Greenland, a new automatic approach



Mapping intertidal zones, coastline extent, small islands and submerged hazards using Sentinel- derived data composites.

to mapping coastlines, submerged hazards (rocks) and intertidal areas was tested. More than 160,000 km of coastline was mapped, including 40,000 small islands and submerged hazards. Various indices and statistical parameters were extracted from time series of SAR data from Sentinel-1 and optical data from Sentinel-2 in order to reduce hundreds of raw images into a few optimized information rich data composites.

An automatic object-based algorithm was applied to the composite data in order to segment ele-

Sentinel time-series provides critical insight on waterline reach in intertidal areas.

ments into various objects of interest, including coastlines, small islands, intertidal areas and submerged hazards.

> **The Sentinel-2 images in time-series and the auto-detected coastline and rocks have been a new primary source in our coast-rock process for new charts in Greenland.**
>
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The utilization of time-series composites and integration of both optical and SAR satellite images significantly minimized the effects from clouds, ice and terrain in order to reduce classification error and derive a seamless classification of coastal areas in the pilot study area. Furthermore, time series analysis of Sentinel imagery provided a detailed insight on tidal areas and dynamics within tidal zones.

Benefits to citizens

The Danish Geodata Agency used the Sentinel-2 images and the auto-detected coastline and rocks in new charts in 2018 and 2019. The biggest benefit is the time-series of images – where it is possible to see the variation in tides and sea ice cover. Images in RGB colors make it easy to distinguish objects such as ice, rocks, etc.

The auto-detected coastline has been a primary source in detection of coast and rock for new charts in Greenland. However, while the technology is a potent and scalable approach to map and monitor remote uncharted areas, special cases still require manual checking of the output data prior to usage. With adjustments of algorithms, over time, automatic detection of coast and rock can be brought closer to an operational level.

Outlook to the future

The Sentinel missions have paved the way for consistent satellite-based operational monitoring of coastal regions and the ability to deliver highly detailed and consistent monitoring of large uncharted areas. However, operational monitoring of large areas using satellite data ultimately depends on the ability to automate processes and data analysis. Deep learning has already been a game changer in remote sensing, and future application of satellite-based operational monitoring systems in coastal regions will ultimately depend on further advancing deep learning technology.

Acknowledgements

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