Measuring Water Depths in Shallow Water Areas using Satellite Imagery

Using state-of-the-art physical based modelling and advanced satellite image analysis to derive high quality bathymetry data at low cost.

Mikkel Lydholm Rasmussen [A], Lisbeth Tangaa Nielsen [A]

A: DHI GRAS

The challenge

High-resolution bathymetric data is a key requirement for managing coastal environments, planning and constructing of marine structures and is also used in modelling efforts aimed at quantifying the effects of extreme weather and climate change. While traditional survey methods provide water depths in detail, these observations are confined in space and rarely repeated due to the high cost of such measuring campaigns. Additionally, the very near coastal zones remain a challenge to survey by boat, leaving many such areas unsurveyed.

The space-based solution

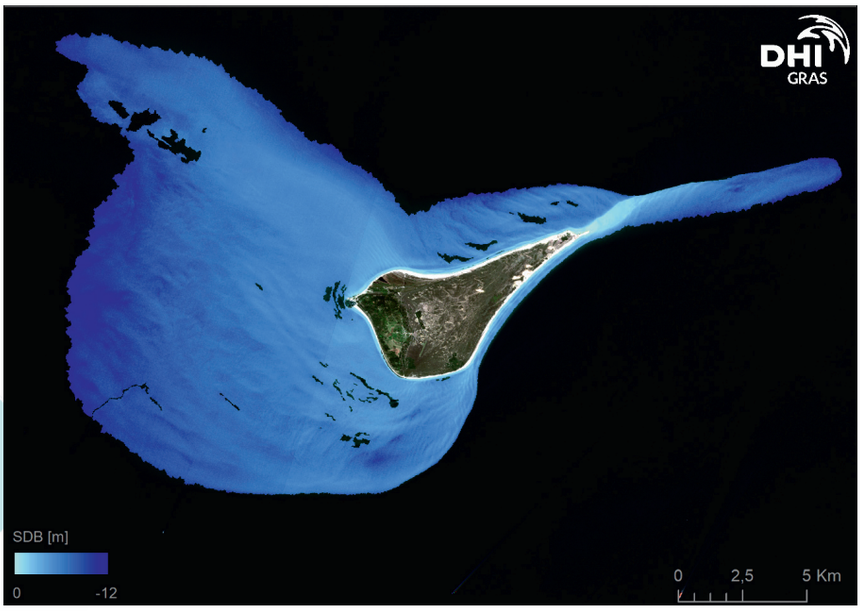
Satellite-derived bathymetry techniques are able to retrieve water depths in shallow water areas using multispectral satellite imagery through the use of physically based models of the optical properties of the water column and seafloor. This allows for cost efficient mapping of water depths over large areas.

By matching the measured reflectances of incoming sunlight from the seafloor obtained from satellites with simulated reflectance, the water depth can be estimated along with water quality parameters and sea floor albedo. Utilizing the high revisit frequency of the Sentinel-2 constellation, imagery with the best environmental and metocean conditions at the time of image acquisition, critical for the satellite-derived bathymetry estimates, can be identified and applied for the analysis. With the continuously growing archive of satellite imagery, satellite-derived bathymetry can be used to analyse the current state, and the dynamics, of the near coastal zone on seasonal time scales.

Uncalibrated satellite-derived bathymetry for shallow water areas near Tauranga, New Zealand.

Benefit to the citizens

While lacking the precision of the physical observation campaigns, satellite-derived bathymetry can provide bathymetric depths covering large



Satellite-derived bathymetry for the area surrounding Anholt produced to supplement a multibeam survey.

areas, bridging the gap between the coastline and traditional surveys in shallow waters and providing a spatial context in areas surveyed by boat. This makes satellite-derived bathymetry an ideal complement for traditional survey campaigns, both in the planning stage by identifying the most critical areas needing observation and by providing a spatial coverage in a much larger area than what can be covered by a physical campaign.

> **Satellite based bathymetry (Sentinel-2) has improved the bathymetric description of 60 Danish water bodies and the quality of mechanistic ecosystem models used for environmental management.**
>
> *Danish Environmental Protection Agency, Ministry of Environment and Food of Denmark*

Additionally, satellite-derived bathymetry allows for identifying and mapping shallow water features in remote areas where the cost and hazards of traditional survey methods are prohibitive, such as in the Arctic. This region, which is currently experiencing increased marine traffic, has many areas which are unsurveyed or very data sparse. Satellite-derived bathymetry is a cost-efficient method for providing bathymetric information in this region that is needed in order to efficiently manage and protect the Arctic coastal zone.

Outlook to the future

DHI GRAS will continue to improve the satellite-derived bathymetry products and expand the database of high-resolution bathymetry in the coastal zone by including different satellite observations and improving the processing methodology. Combining the new generation of satellite laser altimetry with the satellite derived bathymetry has the potential to decrease the need for calibration data obtained from physical campaigns, especially in large remote areas with little or outdated information, thereby increasing its accuracy.

Acknowledgements

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