Satellite-based Monitoring of Coastal Dynamics

The Sentinel missions offer unprecedented potential for monitoring coastal dynamics and geomorphological changes in the coastal zone.

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The challenge

Rapid changes in the coastal zone, such as storm erosion and accretion rates in the tens of meters per year, cause major challenges for governmental authorities, municipalities, and land owners alike. The lack of up-to-date data means that forecasting and prediction of future coastal changes are based on historical information. While surveys are fundamental for understanding and predicting changes in coastal environments, traditional methods are costly and slow, causing inadequately updated information capable of dealing with the variability and trends on e.g. seasonal scales needed to fully understand these dynamic environments.

The space-based solution

By leveraging the high revisit frequency of Copernicus earth observation data, particularly those of the Sentinel-1 and Sentinel-2 missions, frequent assessments of the status of the coastal environment can be performed, providing up-to-date information on topics such as erosion of exposed coastlines and changes to marine habitats. Through automatic processing of all newly acquired Sentinel-2 imagery, the effect of erosion mitigation strategies such as beach nourishments or newly constructed breakwaters can be monitored and evaluated. Additionally, by processing the historical archives of satellite imagery a solid baseline can be established to serve as a consistent and reliable basis for long-term forecasting, evaluation, and planning of mitigations and impact monitoring of coastal management choices. The coastline and beach width are accurately mapped in each acquired image by combining observations from the optical and near-infrared bands with indices and windowed statistical calculations employing machine-learning methods. The mapped coastline is then compared to harmonics-based tidal data to account for the variability in instantaneous water levels caused by the tidal cycle.

> **Accurate and continuously updated earth observation satellite data provided by the Copernicus missions serve to advance and to detail our understanding of coastal changes e.g. in relation to storm erosion, and provide for optimized coastal protection measures and enhanced environmental monitoring.**
>
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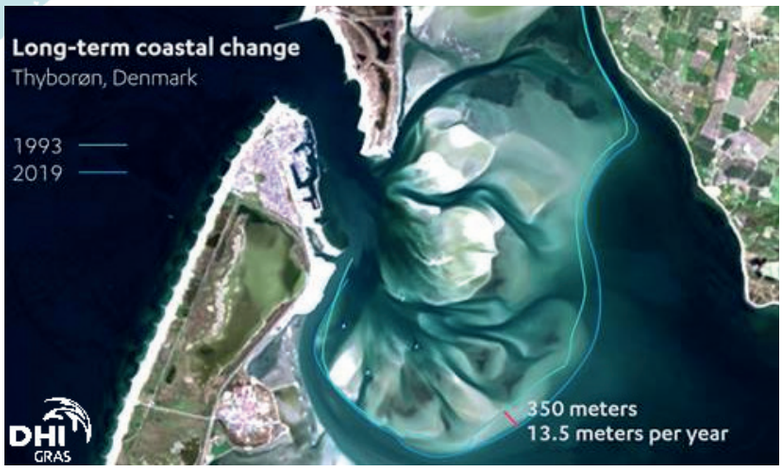
Benefits to citizens

Accurate and up-to-date information on coastal dynamics provides the governmental authority and municipalities with the data they need to accurately plan and assess the impacts of previous erosion mitigation and climate adaptation initiatives. This leads to more efficient and effective erosion coun-

Coastline development at Port Fourchon, Louisiana, between February and October 2019.



Satellite based monitoring of long-term coastal change around Thyborøn, Denmark.

termeasures, where such are applied, and more accurate modelling and forecasting in areas where the environmental protection frameworks entail that the coast develops naturally. By using satellite imagery to provide a map along the entirety of the exposed coastline, instead of only isolated transects based on in-situ measurements, no area is left unassessed. This greatly increases certainty and a holistic understanding of which areas are experiencing erosion or accretion. This can also facilitate the identification of potential new sites for sourcing sand for beach nourishments or even as sources of raw materials for concrete production.

Outlook to the future

DHI GRAS will continue to improve on the accuracy of the automated assessment of erosion and accretion rates, while also looking into enhancing the user-interface to facilitate a wider adoption of the developed tool chain. By making it as user friendly as possible, it becomes possible for individual coastal modellers and interested citizens to access up-to-date and state-of-the-art data on coastal dynamics anywhere in the world. This widespread access to information will make it possible to effectively utilize the global nature of the Copernicus data and open up for an increased understanding of the coastal environments in data sparse regions.

Acknowledgements

The authors would like to thank the Danish Coastal Authority for providing transect data and the Danish government for providing financial support for development of tools for data-based marine and coastal management.