



MANAGING COASTAL RISK

Setting a standard for coastal products using SENTINEL 1 & 2

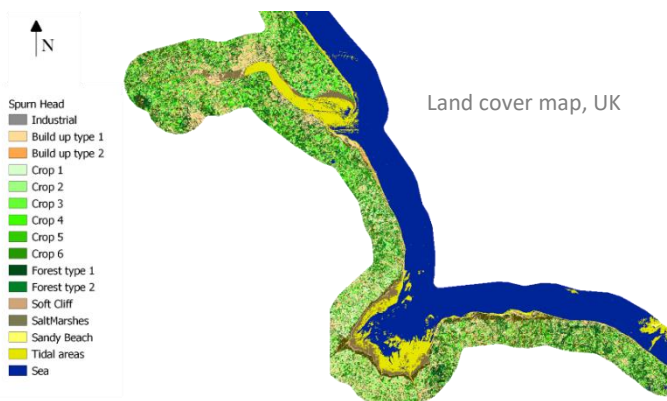
An Executive Summary For the past 3 years a specialist consortium comprising the national geological and environmental/hydraulic experts from five nations have joined with specialists from industry in Earth Observation exploitation to design, develop, test, manufacture and validate a series of Earth Observation products. These products comprise accurately positioned **waterlines**, ie the land/sea boundary at the time of the satellite passing, **shorelines**, ie a waterline projected to a specific datum such as Mean Sea Level and **Coastal Land Cover** maps to identify the nature of the backshore area. These products identify historical coastal change over 25 years, employing both **SENTINEL 1 & 2** mission alongside Landsat by providing real evidence to inform risk assessment and determine where future investment in sea defences, beach renourishment or managed realignment should occur. The intended customers for these product outcomes are those engaged in managing coasts, the insurance associated with coastal investment, planning and coastal engineering work.



Waterline in Catania, Italy

In fact, over the course of the project more than 7300km of coastlines from 5 countries were observed across numerous differing geomorphological sites to demonstrate that the innovative techniques developed are truly scalable worldwide. The sites chosen were selected to represent a variety of coastal environments and climate change challenges.

What also became clear very early in the project, based on the user requirements being collated from the numerous stakeholders, was the need for high temporal and spatial resolution of the coastline before and after events such as severe storms to avoid aliasing the time-series and confusing temporal erosion from structural erosion.



All the products have been validated by the user group and scientific papers have been released by each participating nation. Another key tenet identified throughout was the need to optimise the number of useable satellite images and to ensure more continuous waterlines and because of this requirement a semi-automatic waterline processor has been delivered employing an adaptive threshold technique for automatically assigning the critical sea/land boundary.

These waterlines are then projected using auxiliary data to provide a sea datum-based line, called a shoreline. The outcome is that continuous shorelines can be mapped over decades using the Sentinel and Landsat Mission data to a degree of accuracy that enables measuring coastal change associated with seasonal variation, storm events and long-term trends. The ability to derive this analysis is also scalable **now** to deliver regional, national, or global indicators anywhere in the world using long term shoreline analysis tools such as the [Open Digital Shoreline Analysis System](#).

The Project Partners This project has been led by ARGANS Ltd who formed a partnership consisting of an EO based information service provider group of Earth Observations and Data experts comprising ARGANS Ltd (UK/Fr), isardSAT (Spain) and adwaisEO (Luxembourg) who delivered to an authoritative public User Group of national representatives from the British Geological Survey, the British government experts, IHCantabria in Spain on behalf of the Spanish government's Ministerio para la Transición Ecológica y el Reto Demográfico (MITECO), Geological Survey Ireland, the Irish Department of Environment, Climate and Communications and ARCTUS representing the Canadian academic world and the local communities of Québec. For the CCN an additional national expert from Italy was added to the consortium, namely the Italian National Institute of Environmental Protection and Research.



Final review meeting in ESRIN-ESA, Frascati

The Headlines The consortium has developed a method to optimise the number of customer ready co-registered waterlines and datum referenced shorelines seasonally covering 25 years that have been validated by the leading geoscience experts within the five partners' nations. These products deliver inter-pixel accuracy, use a locally adaptive threshold method to accurately determine the position of the land/sea boundary precisely and can be scaled to cover complete nations worldwide. Indeed, each partner nation intends to further expand this work to provide national coverage. We have developed a land classification map describing the coastal strip, including coastal features and their inter-annual changes which enable beach width to be determined.

In addition, the use of Sentinel-1 SAR derived waterlines has been fully exploited and can in many cases show erosion or accretion trends based on a number of demonstration sites. Despite the numerous challenges related to SAR technology, isardSAT have developed an innovative approach to capturing the dynamic interface between land and sea to clearly demonstrate coastal change via time series. The repeatability and number of observations make SAR technology optimum for identifying coastal change in challenging environments.



Bull Island, (ROI) case study using S1 SAR

The project's outline This project consisted of three phases. **The first phase** enabled the User Requirements to be collated and then for them to be refined into the art of the possible based on the existing and archive technologies and the innovative approaches that could be developed within this feasibility phase. **The second phase** moved to implementation where both production and validation became the key tasks. Alongside this work were two additional requirements placed upon the consortium, namely, to develop a pilot data access service and also to broadcast the range of new products, their development, validation and utility via a series of workshops hosted in the four participating nations. The initial plan had been to host these as live events within the partner institutions; however, the onset of the global COVID-19 pandemic required these events to become virtual. This approach proved most popular with in excess of 600 delegates attending the events. **The third phase** supplemented the user requirement based on lessons identified and feedback from the workshops. This phase provides an additional 1500km of coastal products, updated all the previous sites' products to mid-2022, added an additional nation (Italy) to the consortium and delivered improved capabilities as well as an additional workshop, this time more focused on the decision makers in local and national government as well as heads of institutions connected with coastal management.

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The Coastal Erosion from Space project was commissioned under the Science for Society slice of the 5th Earth Observation Envelope Programme (EOEP-5) of the European Space Agency.