SPACE FOR SHORE

The Space for Shore consortium, led by the French SME i-Sea and involving partners across Europe in 6 countries where coastal erosion is a critical issue, has been working for 3 years to demonstrate, using a set of coastal indicators, the relevance of Earth observation products to address coastal erosion monitoring.

This ESA-funded project (EOEP-5) aimed to make the most of historical and current EO data (in particular Copernicus Sentinel-1/2) over the last 25 years, showing how they can provide accurate and relevant knowledge on all types of European coastal systems.

To achieve this challenging objective, Space for Shore's guideline has been to focus on the extraction of all key indicators of coastal erosion by seeking comprehensiveness and relevance in the range of data and EO methods that can add value to coastal change assessment at both local and large scales, from short to long term.

All pilot countries and regions were selected according to their representativeness of the variety of European coasts, i.e. depending on their geomorphological setting and their degree of exposure to oceanic forcing, which determine what coastal erosion proxies are requested by European coastal managers.

esa Coastal Erosion Project

European Space Agency

After three years of work and collaboration with scientific experts and coastal managers, we have developed a set of robust and relevant indicators that have been deployed on more than 4500 km of coastline over the last 25 years. Thanks to this large-scale demonstration, the indicator detection algorithms are now ready to be deployed, on demand, on all European coastal systems, to provide coastal managers with valuable data for their decision-making and risk reduction policies.

Key numbers

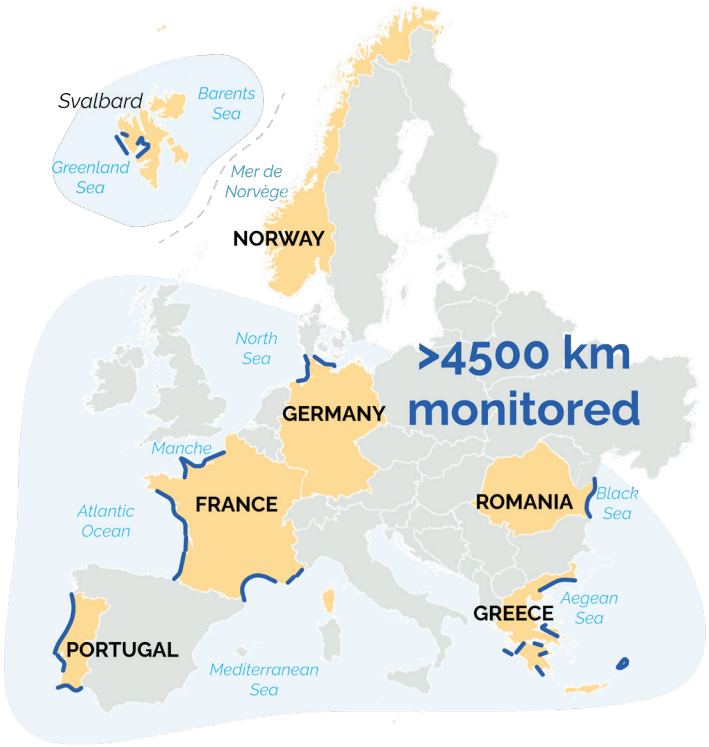
6 countries

91 pilot sites

4500+ km processed

3600+ products

70+ engaged coastal organisations



Remote sensing offers major benefits for coastal dynamics assessment

FROM LARGE-SCALE TO LOCAL MONITORING

A significant volume of optical and radar satellite data was processed along thousands of kilometers of coastline in the six involved countries, as illustrated beside.

The spatial coverage of each satellite image allows covering large areas in a very short processing time using automated algorithms based on artificial intelligence and the latest scientific and technical developments.

The strength of satellite imagery in covering large areas at high frequency, combined with artificial intelligence, gives us the ability to produce data from national to local scale on demand, with high responsiveness. This implies that data extracted from satellites can be used as a warning system for scientists and coastal managers, helping to detect early signals of change.

i-Sea · esa · Brockmann Consult GmbH · cesam universidade de aveiro centre for environmental and marine studies · Harokopio University · TERRASIGNA · Kapitech · HARRIS · TERRA SPATIUM SA · Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG

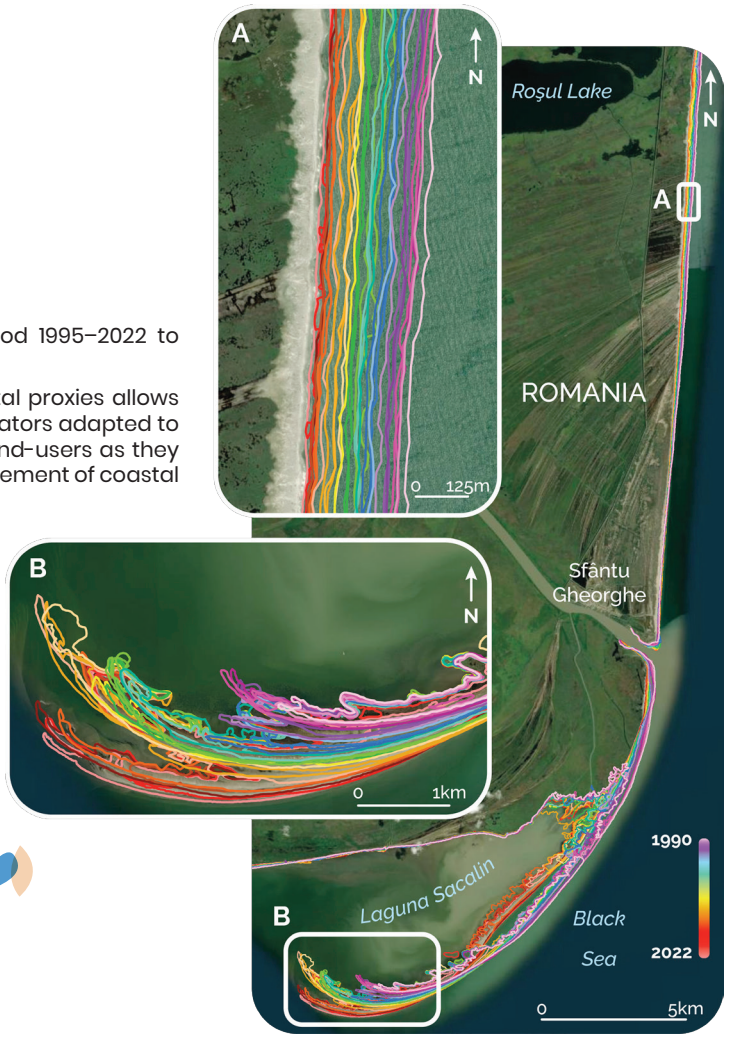
Shoreline changes: from long-term trends to short-term evolution

Thousands of satellite images have been processed over the period 1995–2022 to assess the shoreline change on the European coasts.

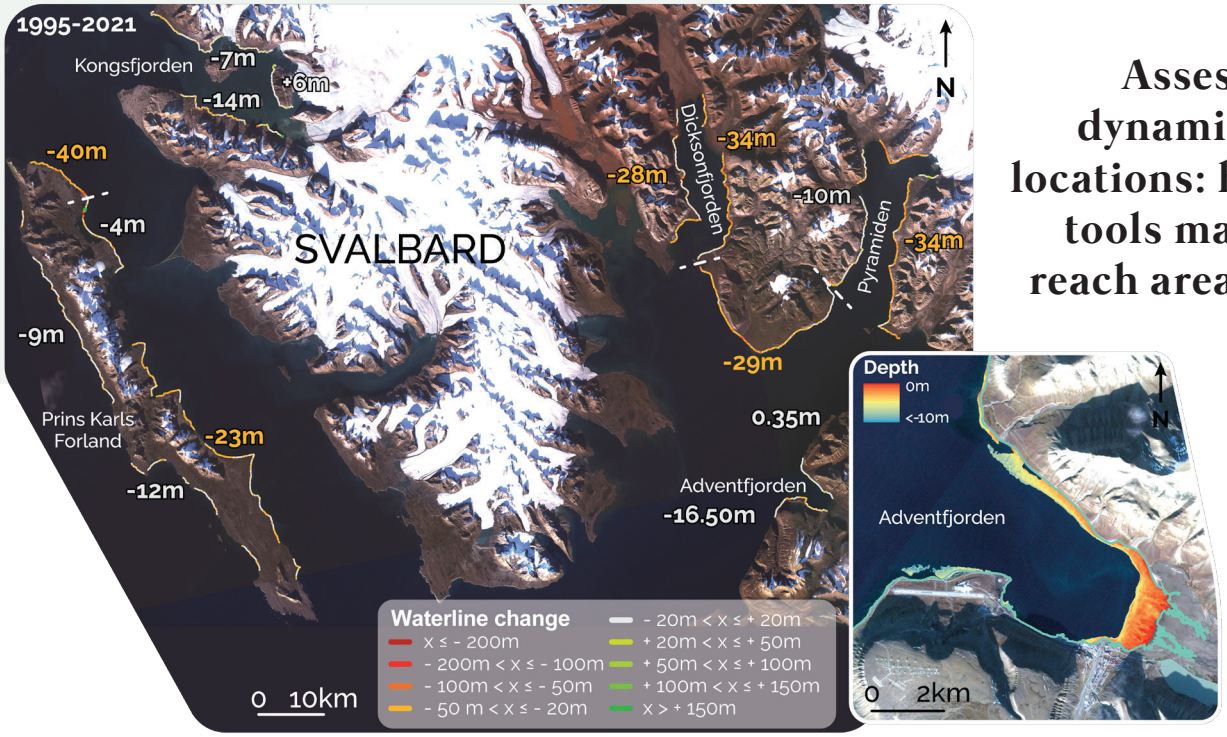
Over the last decades – i.e. long term – the detection of various coastal proxies allows providing knowledge on coastal dynamics (figure beside), using indicators adapted to the characteristics of the pilot sites and to the expectations of the end-users as they themselves have defined the products useful for the study and management of coastal zones.

This long-term approach, which relies on the extensive archive of satellite images available, therefore provides a high frequency (i.e. annually, monthly…) overview of coastline change patterns. In addition, the processing of archives provides historical data on areas for which there is no knowledge on coastal dynamics.

At shorter timescales, satellite remote sensing was also found to be relevant to assess abrupt changes occurring at the beaches during and after major storm events. The immediate impact can be rapidly evaluated just afterwards the storm and then consecutively, the level of natural adjustment or recovery of the beaches in the successive months and years.



Assessing coastal dynamics in remote locations: how satellite tools make hard-to-reach areas accessible



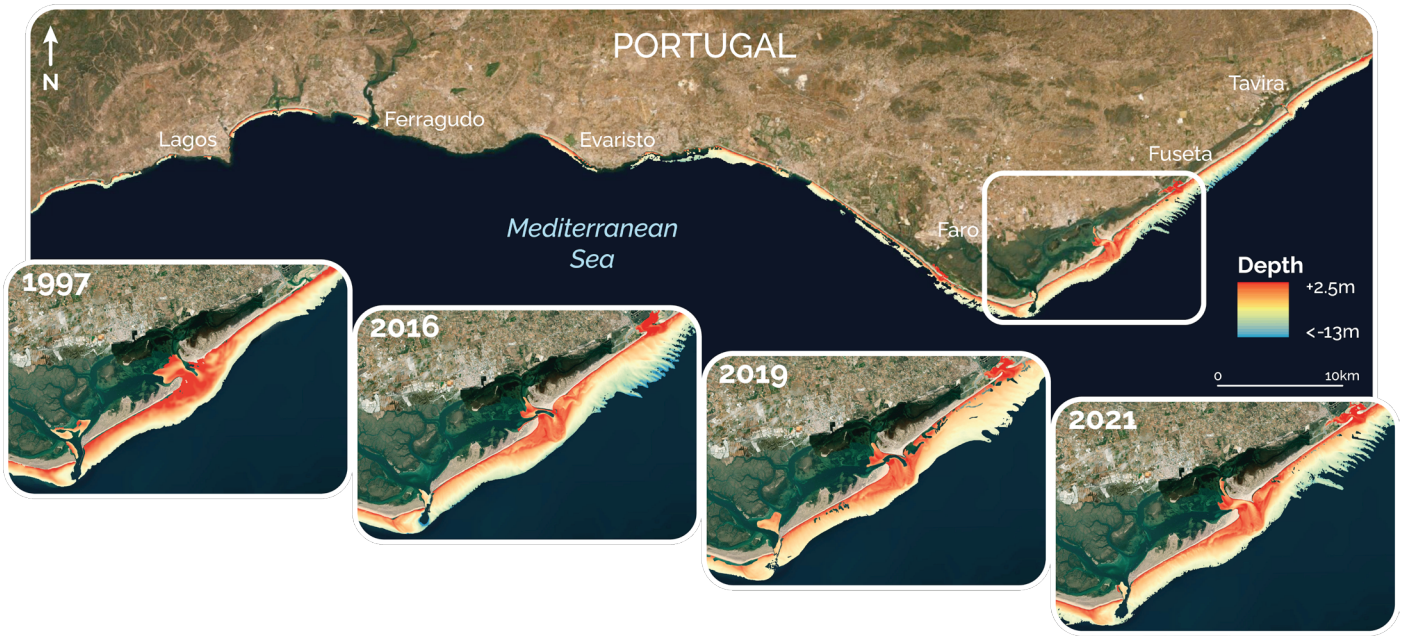
Since satellite images are available everywhere, they offer a unique opportunity to assess coastal dynamics in hard-to-reach areas where data are missing or limited. This major advantage allows providing historical and up-to-date data to assess coastal dynamics in regions of the globe that are particularly exposed to the expected consequences of climate change, as is the case here on the polar coasts (Svalbard Archipelago, Norway) or on small tropical islands.

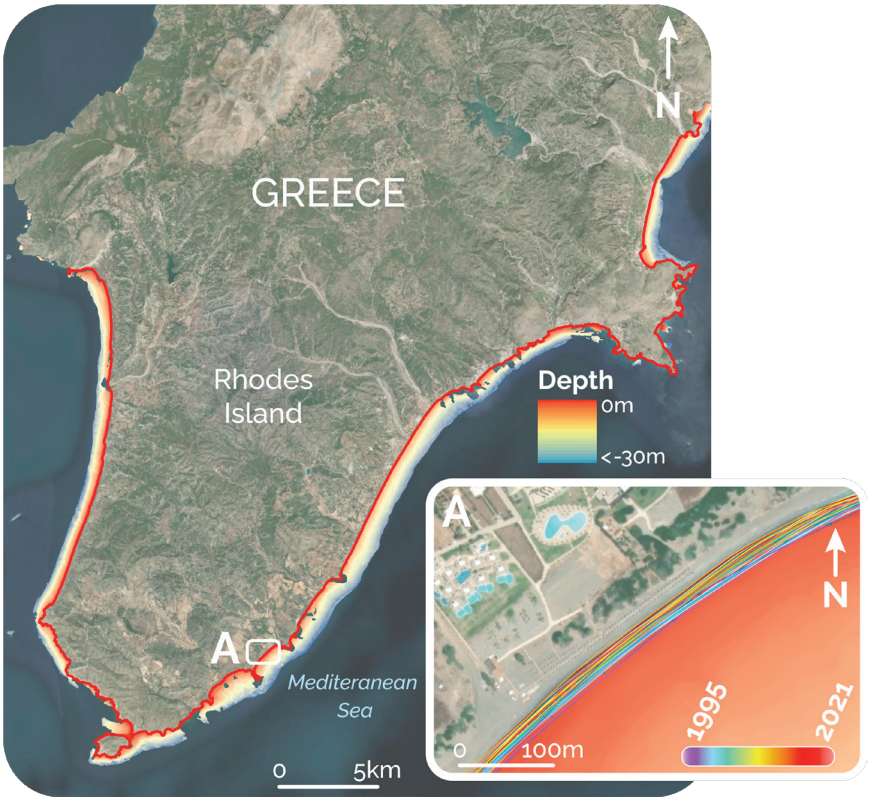
Automatic analysis of satellite imagery can extract valuable data for coastal management or process understanding, while reducing the costs associated with instrumentation in these remote areas. High-frequency satellite data can also be used as an early warning system for climate change impacts, especially in polar areas, by assessing annual rates of glacier retreat, for example.

Assessing nearshore dynamics

While the assessment of coastal change provides essential guidance to coastal managers, it only considers planimetric changes. To fully address the issue of coastal dynamics, satellite-derived bathymetry has also been computed on European coasts wherever the environmental characteristics allow it. This approach, which is known to produce reasonably precise results (less than 50 cm vertical accuracy) to a depth of about 20 metres, has been deployed in several locations in France, Portugal, Greece, Norway and Romania.

Here is an example of satellite-derived bathymetry on the south coast of Portugal in the Algarve region (136 km) over the last 25 years, computed using Spot-2/5 and Sentinel-2 data archives (no calibration data was required).

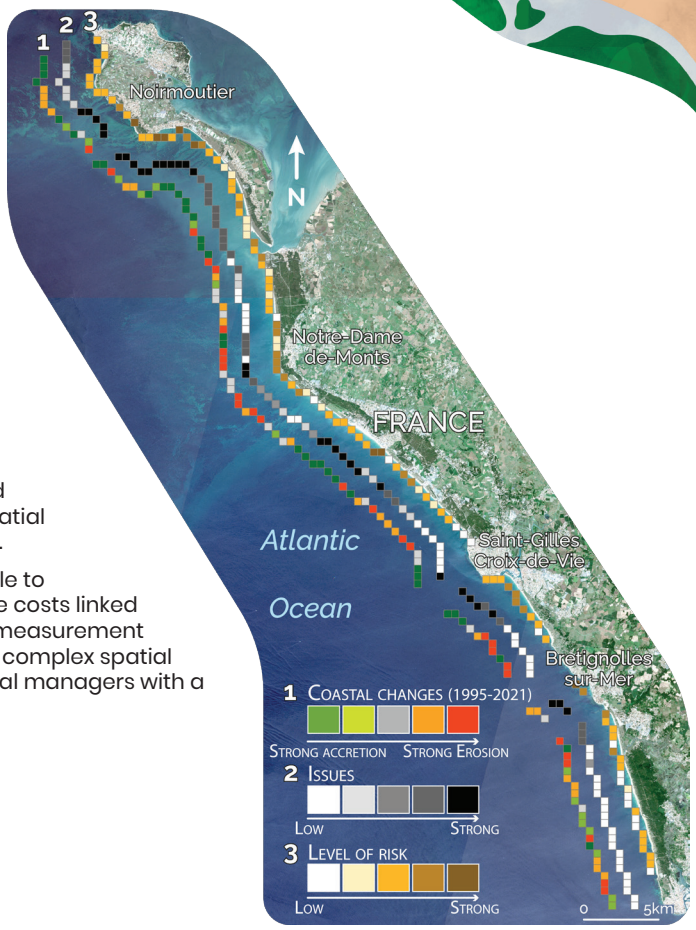




Thus, in many coastal areas in Europe, changes in nearshore bathymetry can be observed with a relatively high frequency (theoretically weekly with Sentinel-2, more realistically a few times a year), providing regular observations of bottom changes at the scale of the coastal system or sediment cell, allowing the assessment of sediment stocks and their variation on relevant time scales of coastal dynamics.

Coastal scientists and beach managers all agree on the advantages of satellite bathymetry, which provides current and easily updated information on beach morphology and bathymetry, with 'a level of accuracy almost equivalent to that of aerial Lidar techniques' (Stéphane Costa, lecturer at the University of Caen, France). These data help to detect natural fluctuations in submarine sediment stocks on seasonal and annual time scales, which is crucial information for the coastal manager in charge of beach and shoreline vulnerability mitigation.

Providing understandable data for all: from coastal dynamics assessment to erosion exposure index



Scientific data on coastal dynamics can sometimes be difficult to understand or synthesise. This is why we have developed an erosion exposure index, which provides an accessible level of information, even for non-specialist users. This index, because its resolution can be adjusted to the scale of the sites covered (i.e. from 500 to 20 m), allows complex spatial information to be synthesised, from the European to the communal scale.

This approach, based on high-frequency data extraction, makes it possible to identify areas at risk of erosion. It can thus make it possible to optimise the costs linked to the monitoring of coastal dynamics for a targeted implementation of measurement systems on the most dynamic sectors with high stakes. The adjunction of complex spatial information – e.g. (1) coastline behaviour and (2) land use – provides coastal managers with a reliable, simple, affordable and adaptive decision support tool.

Our Flagship Geoportal

In order to ensure the widest possible dissemination of the data produced, they are all accessible on our geoportal for consultation and downloading. In the future, this platform will allow any end-user (e.g. coastal managers, scientists) to order data on the coastal dynamics of their region.

To request access to the portal, simply send a demand to **info@i-sea.fr**.

Link to the portal: **https://space4shore.staging.services4eo.com/home**

In Short

THE KEY BENEFITS OF EO-BASED DATA

- Major asset for understanding and managing the coastal zone
- A wide range of proxies for all types of coastal systems
- High frequency image acquisition to cover all temporal ranges
- A huge number of historical data to look back in the past
- High computation time/area processed ratio with remote sensing
- Constant and rapid map updating of the erosion hazard
- Complementary to field data and allowing their optimisation

LARGE-SCALE DEMONSTRATION MEETINGS IN 2022

- 100+ participants in all the involved countries
- 50+ organisations representative of coastal stakeholders

Find all information about the ESA Coastal Erosion at **http ://spaceforshore.eu**
contact us at **info@i-sea.fr**