Professional tutorial

In the frame of the Earth Observation Envelope Program (EOEP-5), ESA has decided to target the Coastal Erosion issue by funding a great project from 2019 to 2023.

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About us

Space for Shore consortium

Led by i-Sea, the Space for Shore consortium is one the 2 project champions selected by ESA.
Our philosophy is based on cooperation between the different SAR and optical remote sensing specialists who address together the most relevant coastal erosion indicators as required by European coastal managers.

Earth Observation Experts

9 technical partners (i-Sea, Brockmann Consult, Terrasigna, Terra Spatium, Harris, Hamburg univ., Univ. of Aveiro, Univ. of Harokopio)
Specialised in optic and radar remote-sensing, IA
6 countries (France, Greece, Germany, Romania, Portugal, Norway)
Support of multiple local experts
Accompanied by Kapitech (space business and consulting)

Link between Science and coastal management

The Coastal Erosion project is end-user driven. Coastal managers are central: (i) they have defined the required products; (ii) they have been sharing their ground truth datasets issued from their current monitoring program; and (iii) they finally tested the new products and give feedback about their relevance.

Needs of coastal zone managers

Assess long-term trends in observed coastal dynamics to anticipate efficient protection and adaptation solutions.

Define vulnerable and susceptible coastal areas to prevent damage.

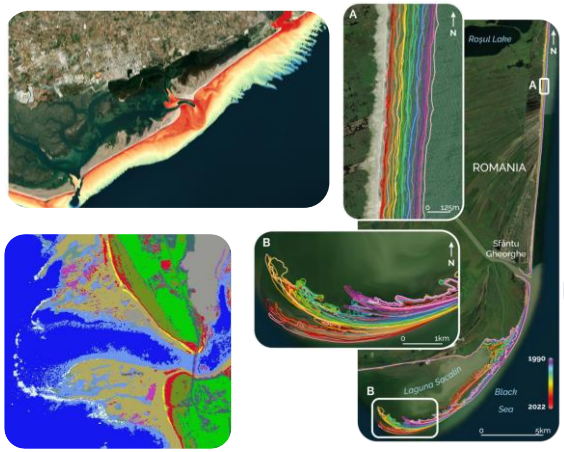
Compare the coastline before and after storms in the past.

Better assess the location and extent of sediment management (replenishment).

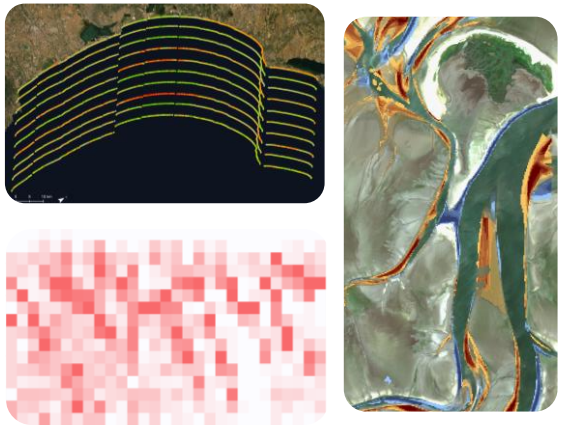
Characterize foreshore dynamics to facilitate navigation and coastal erosion management.

Supporting coastal management stakeholders with a rich and innovative technology

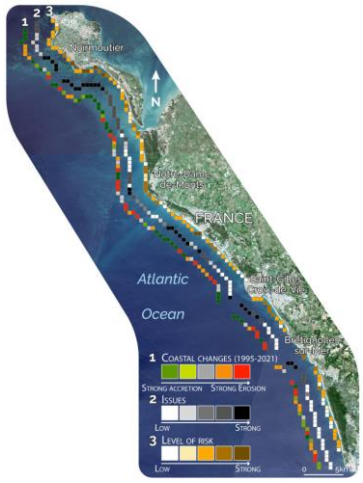
Automation of big data collection derived from satellite imagery



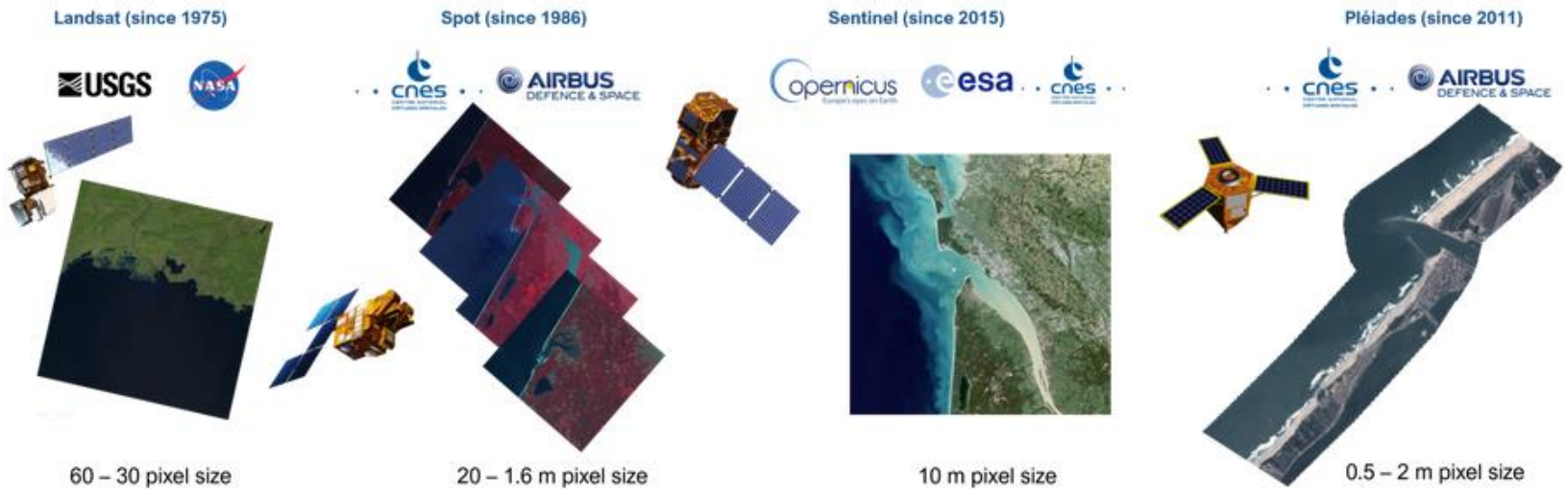
Statistical analysis of the observed dynamics



Synthetic and adapted representation of the conclusions



Added-value of satellite-derived products



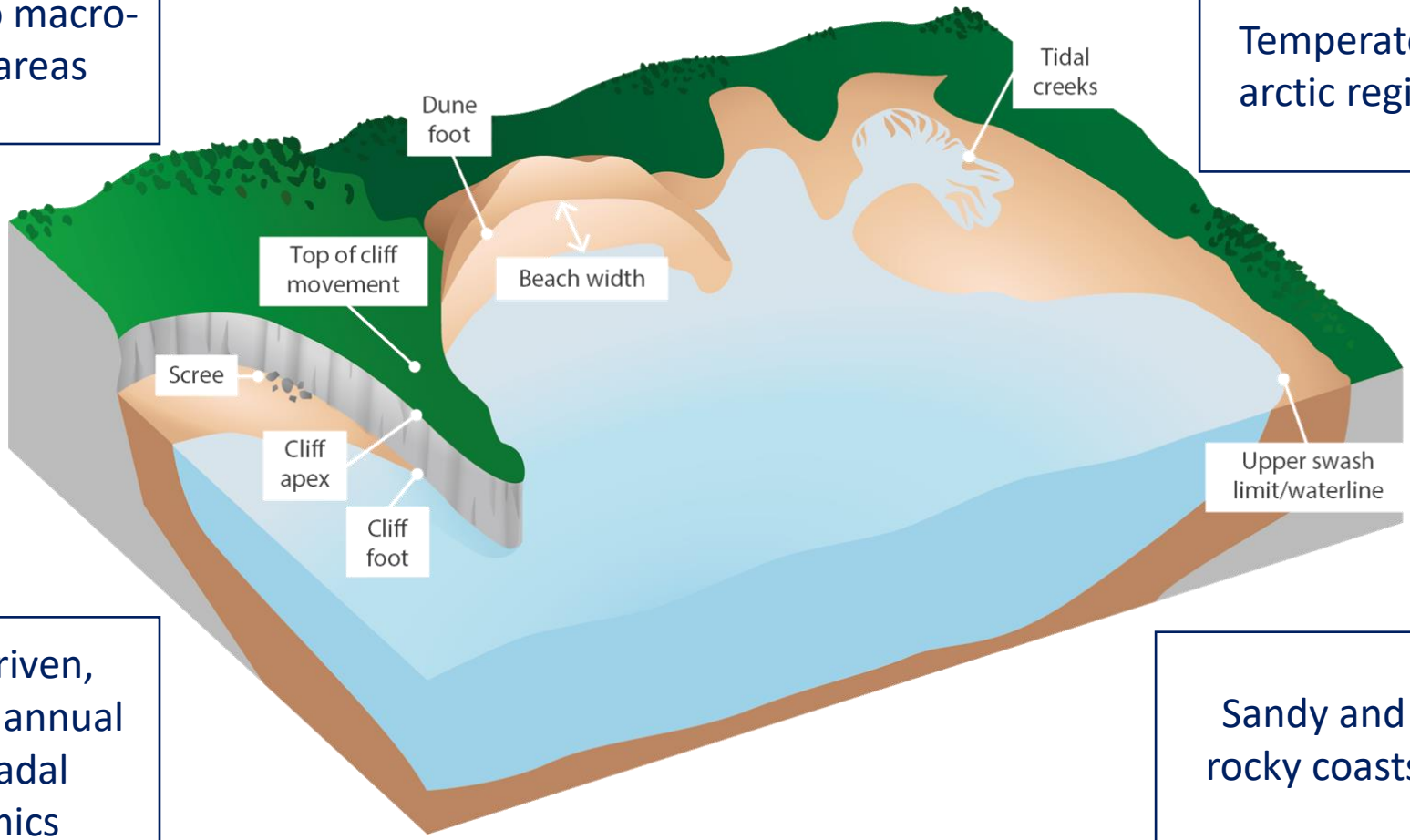
✓ **Up to daily acquisition** ✓ **Up to ~50 years of retrospective** ✓ **Up to global coverage**

	Revisit	Coverage	Period	Precision	Processing time	Cost
High-resolution satellite image	+++	+++	+++	+	+++	€
Very high-resolution satellite image	+++	+++	++	++	+++	€/€€
Lidar/Aerial photography	+	++	+	+++	+	€€€
Field survey	++	+	++	+++	++	€€/€€€

Indicators of coastline dynamics

Micro to macro-tidal areas

Temperate to arctic regions



Event-driven, seasonal, annual to decadal dynamics

Sandy and rocky coasts

Useness:
Monitor coastal changes at high time-frequency and using the adapted morphological indicator
Better prepare the field surveys
Feed discussions about coastal management, decision-making, engineering solutions

Indicators of coastline dynamics

SANDY / MUDDY COASTS

Waterline

Upper and lower swash limit

Dune foot position

Beach width

Vegetation limit

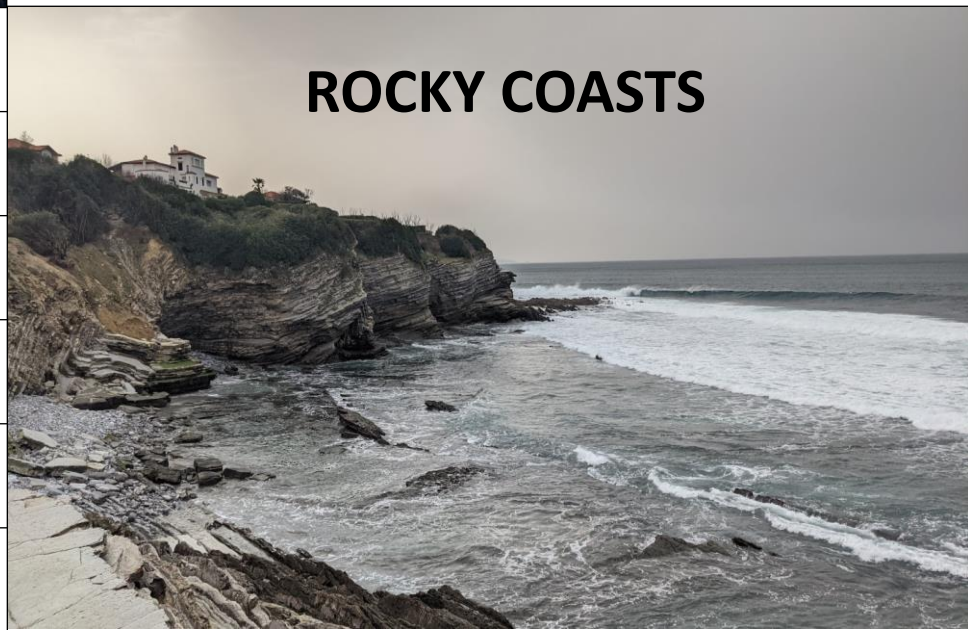
Intertidal banks and channels

Sea-cliff lines

Screes

Gravity movements

ROCKY COASTS



Information for proper data use

Satellite	Resolution	Mean precision of the result	Maximum reading scale	Maximum analysing scale
Sentinel 1/2	10 m	3-5 m	1:2000	Display of minimum 3 pixels to identify a reliable morphology
Landsat	30 m	10 m	1:6000	
SPOT	1.5-20 m	3-7 m	1:1000	
Pléiades	2 m	1.5-2 m	1:400	

Comparison of dates

Seasonal homogeneity for analysing a multi-year evolution

The interval between dates should be adapted to the known general dynamics of the site and the accuracy of the measurement.

Indicator extracted from several images (multidate product)

Indicator representative of a season or period. Incorporates natural inter-date coastal dynamics.

The greater the number of images used, the more representative the product is of the period.

In macro-tidal environment, particular attention should be paid to the dates used.

Use of products to estimate future projections

To be avoided if irregular evolution in the historical trend

Consider envelopes of future changes rather than exact values

Waterline position monitoring

Waterline

Limit between the marine and terrestrial parts of the coastal system

Change in waterline position

Regularly spaced transects highlighting hotspots of shoreline erosion

Surface area comparison between 2 dates

Suitable for comparison of shoreline condition before/after storm.
Microtidal areas during low wave agitation conditions.

Not suitable to survey the shoreline representative of a season, or to quantify seasonal, annual, or longer-term changes.

For the conditions listed that are not suitable for this indicator, opt for the "High and low limit of the swash zone" indicator.

Upper and lower swash limit

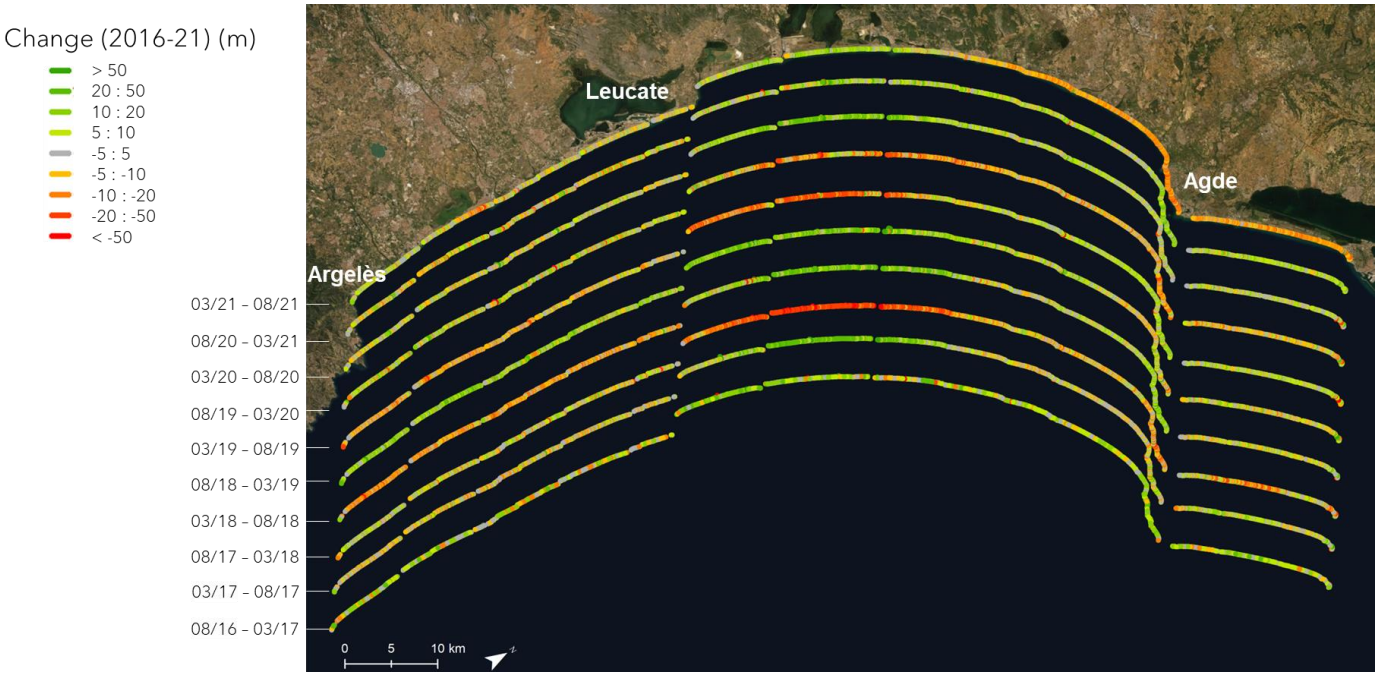
Upper / lower swash limit

Highest & lowest position reached by the water on the beach over a selected homogeneous period.

Change in swash limit

Regularly spaced transects highlighting hotspots of shoreline erosion

Surface area comparison between 2 dates



Suitable for locating the seasonal position of the shoreline, quantifying seasonal and annual changes.

Not suitable for pre-post storm change monitoring, or for a macro-tidal dune environment.

For the conditions listed that are not suitable for this indicator, opt for the "waterline" or the "dune foot position" indicators.

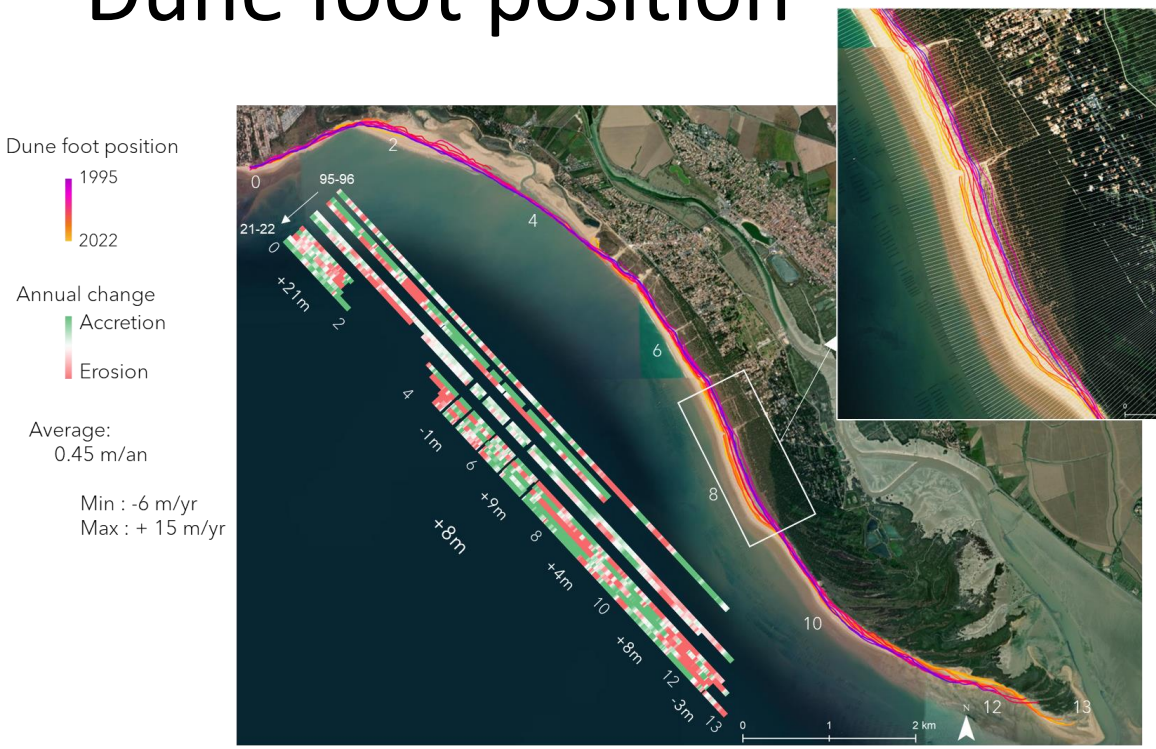
Dune foot position

Dune foot position

Change in slope at the base of the seaward side of the dune

Change in dune foot position

Regularly spaced transects highlighting hotspots of shoreline erosion



Suitable for monitoring a coastline with a developed dune system, whose dynamics are multi-metric over the chosen monitoring frequency.

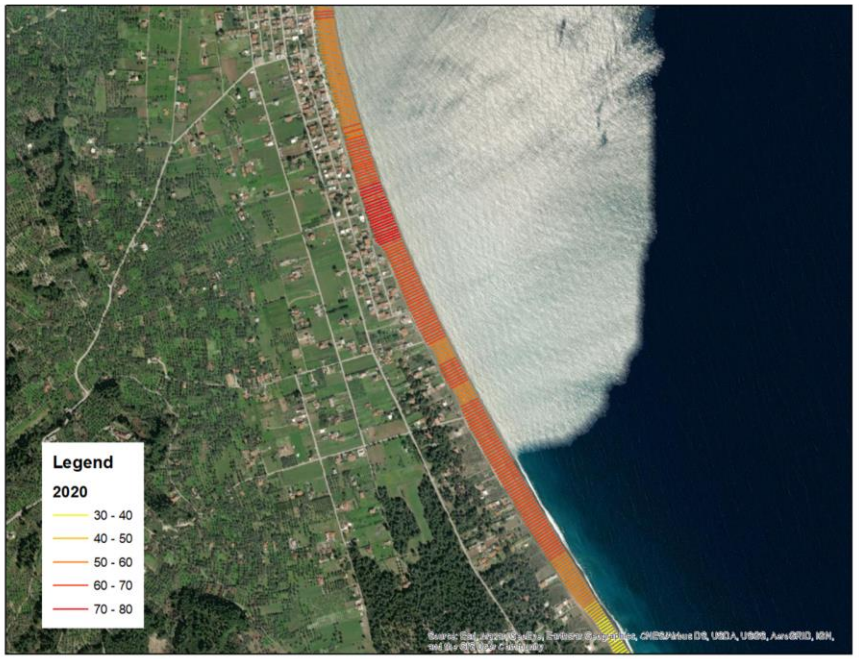
Not suitable for monitoring old, stable and/or poorly developed dune systems.

For the conditions listed that are not suitable for this indicator, opt for the "beach width" indicator.

Beach width

Beach width
Distance between a reference line denoting the foot of either the dune, or the cliff, or a defence structure, and the waterline computed at low tide (total beach width), high tide (upper beach width) or using a time-averaged waterline (mean beach width in microtidal environment)

Change in beach width
Regularly spaced transects highlighting hotspots of narrowing of the beach width.



Suitable for beaches several tens of metres wide, subject to dynamics at the bottom and top of the beach.

Not suitable for narrow beaches, given the resolution of the images. Adapt the selection of images according to their resolution.

For the conditions not suitable, favour a beach surface analysis. The surface area can be estimated from the beach limits used for the width calculation.

Vegetation limit

Vegetation limit

Position of the sea-side vegetation boundary

Change in vegetation limit

Regularly spaced transects highlighting hotspots of vegetation squeeze.

Suitable for mature vegetation fringe, long-term trends of evolution or exceptional stormy events

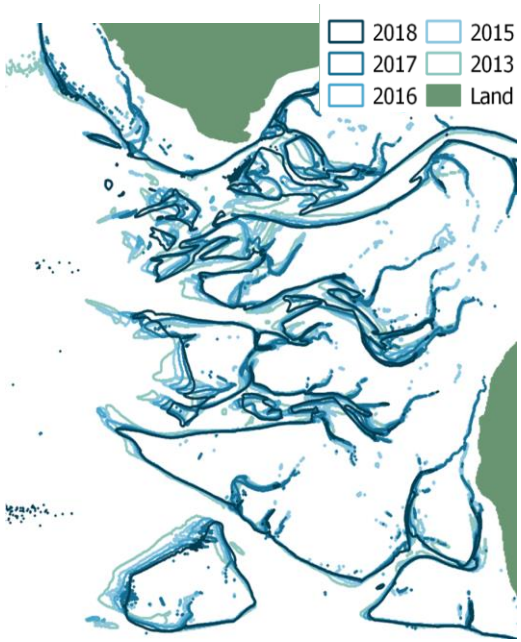
Not suitable for young scattered vegetation, indirectly connected to sea, seasonal or shorter-term dynamics.

For the conditions not suitable, favour the "High and low limit of the swash zone“ or the “waterline” indicators.

Intertidal creeks and chanels

Intertidal creeks and chanels

Structures of differential erosion related to the influence of marine waters during tidal cycles on the sandy-muddy sedimentary material. The creek edges mark the limits of these channels



Suitable for meso- to macro-tidal sandy/muddy areas.

Not suitable for micro-tidal areas.

For the conditions not suitable, favour the "High and low limit of the swash zone“ or the “waterline” indicators.

Sea-cliff lines

Sea-cliff lines
Top and bottom of cliffs to identify collapse notches.

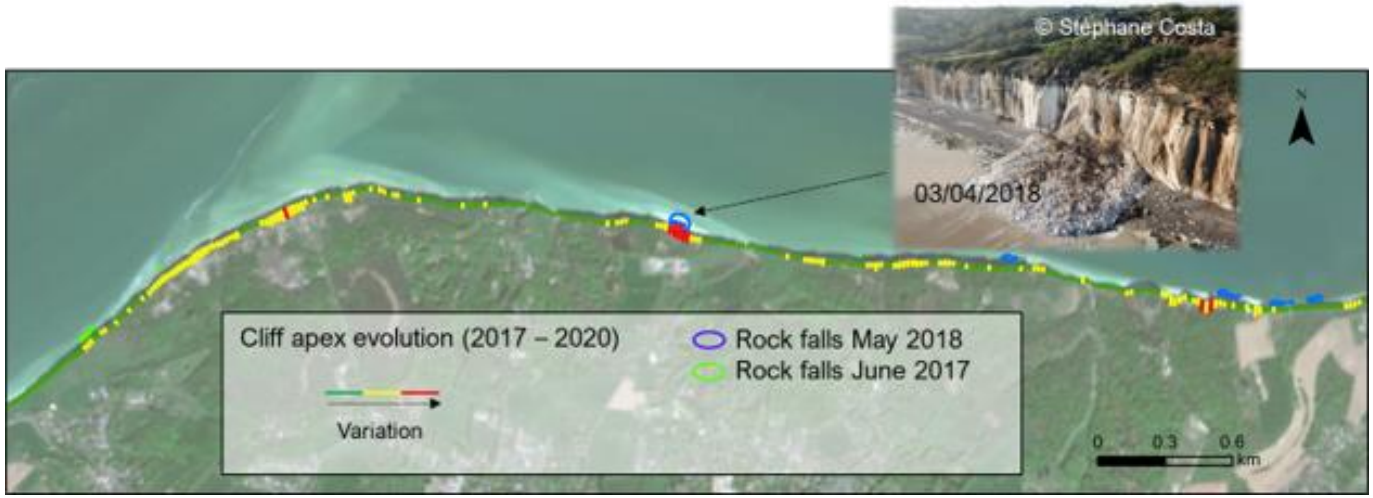
Suitable for steep cliffs

Not suitable for stable cliffs.

For the conditions not suitable, favour the "Screes" location indicator.

Screes

Scree location
Position and shape of rocky cliff collapse deposits. Combined with an analysis of the mobility of the cliff lines, the event can be dated.



Suitable for steep cliffs

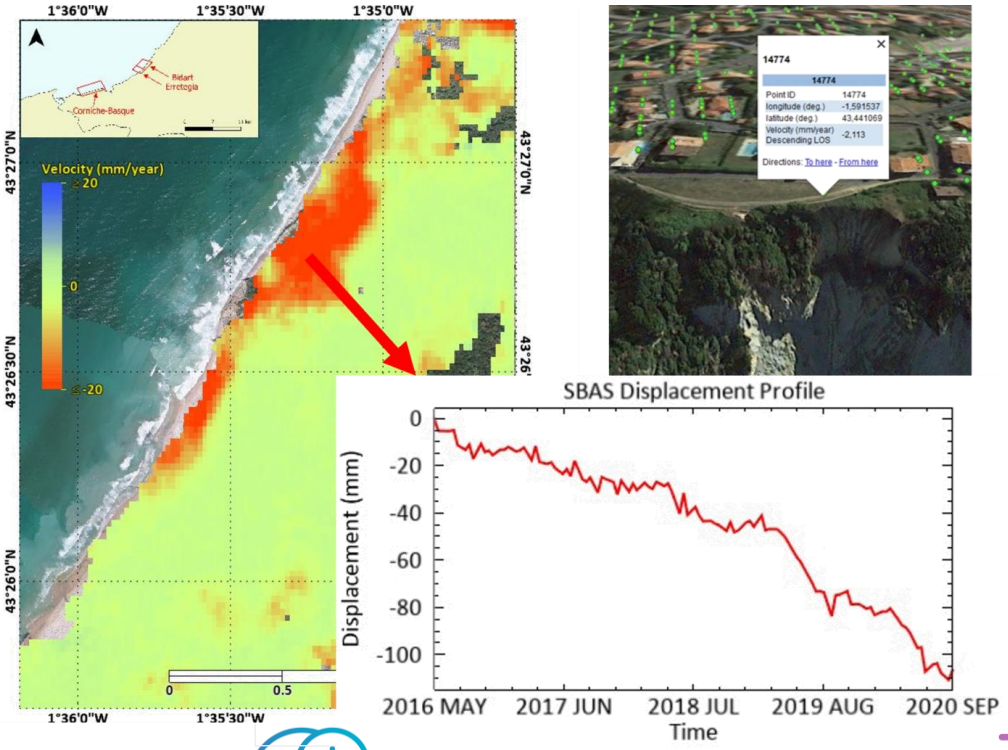
Not suitable for stable cliffs.

For the conditions not suitable, favour the "gravity movements" indicator fo anticipate or observe collapse.

Gravity movements

Gravity movement

Ground deformations are monitored to prevent or observe landslides and rocky collapses



Suitable for highly erosive subvertical sea-cliffs.

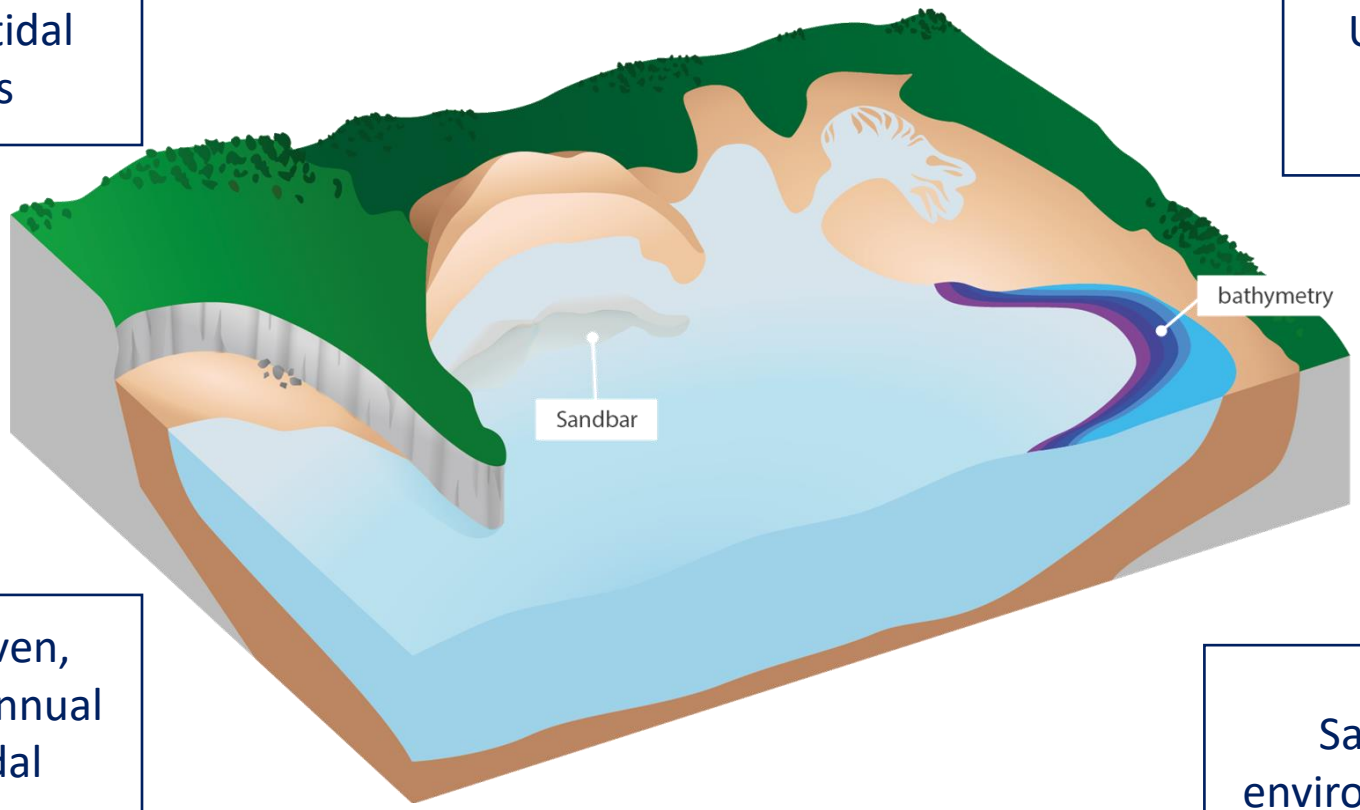
Not suitable for ancient, vegetated, and stable cliffs.

For the conditions not suitable, favour the "scree" detection to locate erosive hotspots.

Indicators of nearshore dynamics

Micro- to macro-tidal areas

Up to 15 m depth



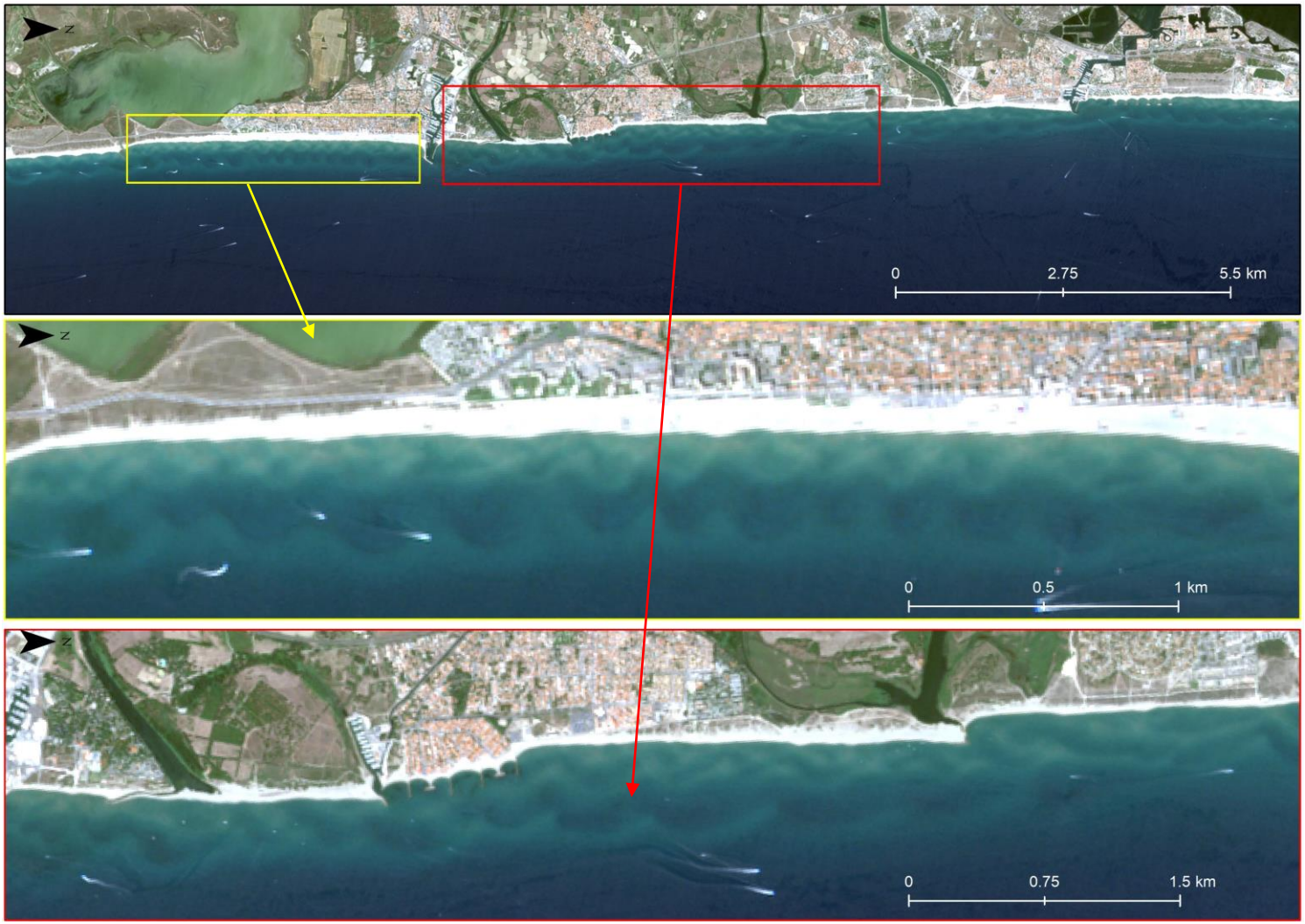
Event-driven, seasonal, annual to decadal dynamics

Sandy environments

Useness:
Assess of sediment stocks and their variation over the relevant timescales of coastal dynamics
Size, locate, and monitor marine renewable energy installations
Prevent sustainable coastal erosion through sediment loss
Gain a better understanding of how the near-shore adapts to storm phenomena...

Indicators of nearshore dynamics

BATHYMETRY **SANDBARS**



Information for proper data use

Satellite	Resolution	Mean vertical precision of the result	Maximum reading scale	Maximum analysing scale
Sentinel 1/2	10 m	0.4 to 1 m To reach 0.4-0.5 m of accuracy: - Homogeneous seabed with high albedo value (sand, limestone pebbles) - Depth between 1m and around 10 m - Nor turbidity or sea surface agitation - Ground control points to distinguish the various seabed types if heterogeneity	1:2000	Display of minimum 3 pixels to identify a reliable morphology
Landsat	30 m		1:6000	
SPOT	1.5-20 m		1:1000	
Pléiades	2 m		1:400	

Comparison of dates

Seasonal homogeneity for analysing a multi-year evolution

The interval between dates should be adapted to the known general dynamics of the site and the accuracy of the measurement.

Indicator extracted from several images (multidate product)

Indicator representative of a season or period. Incorporates natural inter-date coastal dynamics.

Pixels do not have the same overlap rate:

If multiple dates for a same pixel, then weighted average.

If a single date for a pixel, then a single value.

Use of products to estimate volumes of sediment stocks

The vertical and horizontal accuracies allow a qualitative estimation of the sediment budgets in the form of orders of magnitude.

Attribute error margin including both vertical and horizontal accuracy

Bathymetry

Bathymetry

Digital Elevation Models in depths

Change in bathymetry

Mapping of vertical differentials from date to date

Suitable for evaluating seasonal to longer-term sediment balance.

Not suitable for fine calibration of sand replenishment and dredging.

Isobaths extracted from bathymetry can provide simplified information that is easier to read in the case of complex bathymetry. Otherwise, opt for the “Sandbar position" indicator which provides an indication of the active littoral drift zone and the main sedimentary displacements.

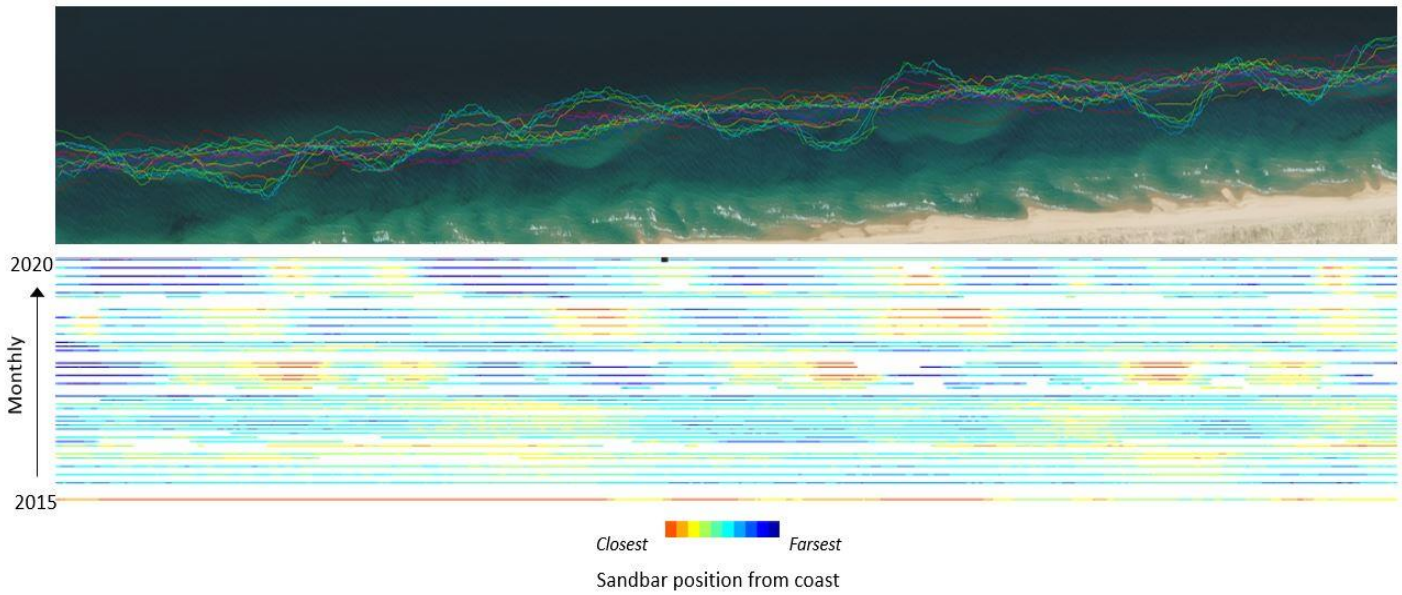
Sandbar position

Sandbar position

Spectral signal associated to the crest of a sandbar or the position of the wave breaking (proxy close to the top of the bar).

Sandbar migration

Distance from coastline to sandbar along perpendicular transects



Suitable for assessing the dynamics of sedimentary stocks in front of sandy beaches, for defining the dynamics during the stormy seasons

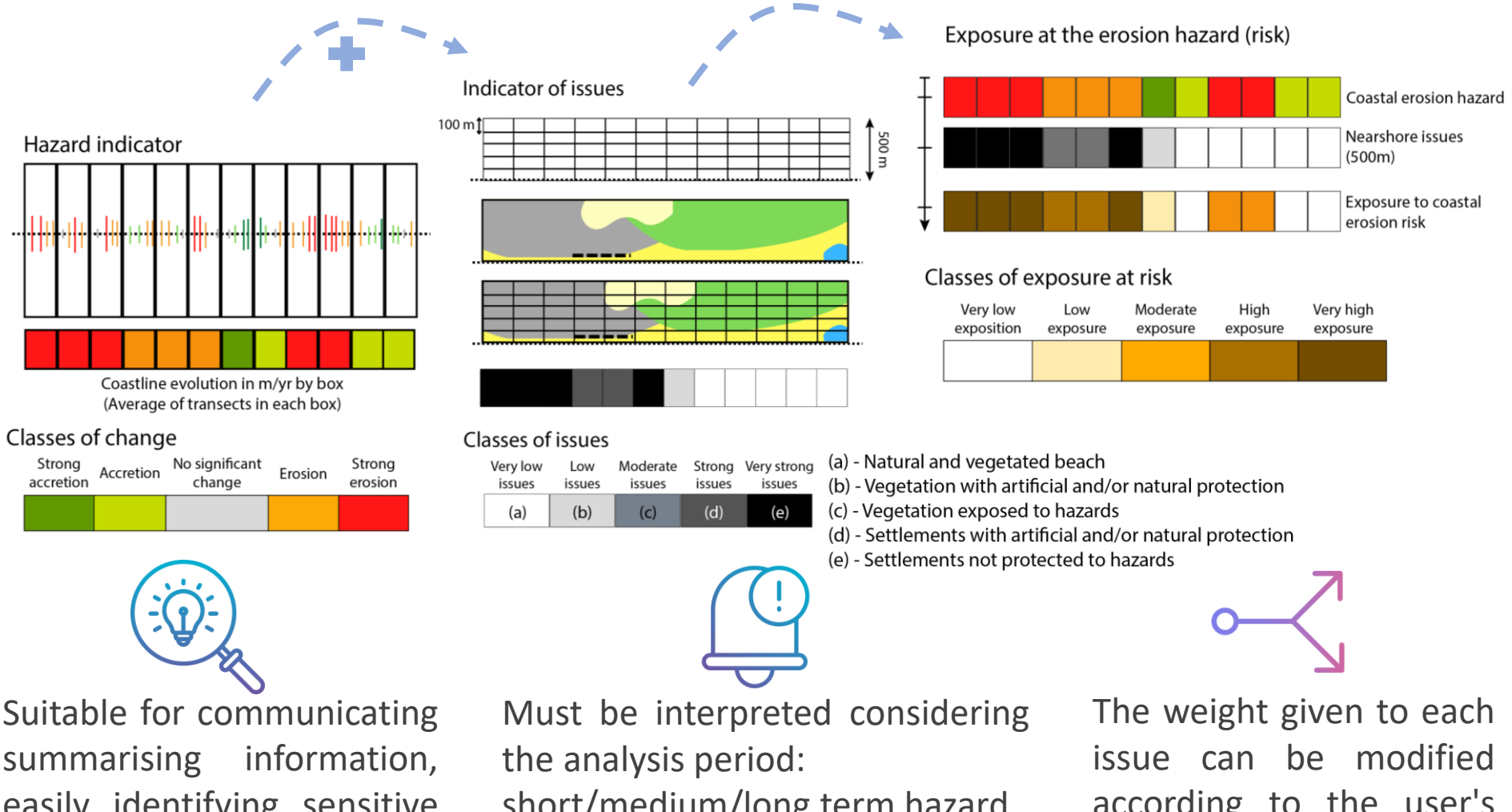
Consider the natural known dynamics, adjust the monitoring frequency.

To be coupled with coastline dynamics for any interpretation of sediment budgets.

Requires good thematic knowledge

For the conditions listed that are not suitable for this indicator, opt for the "bathymetry" indicator.

Exposure at risks



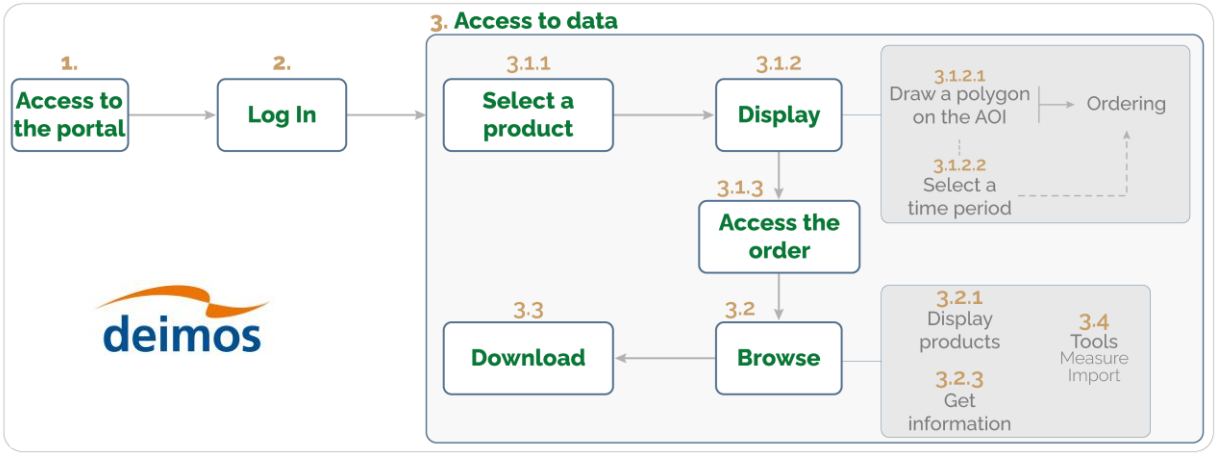
Suitable for communicating summarising information, easily identifying sensitive sites and supporting decision-making.

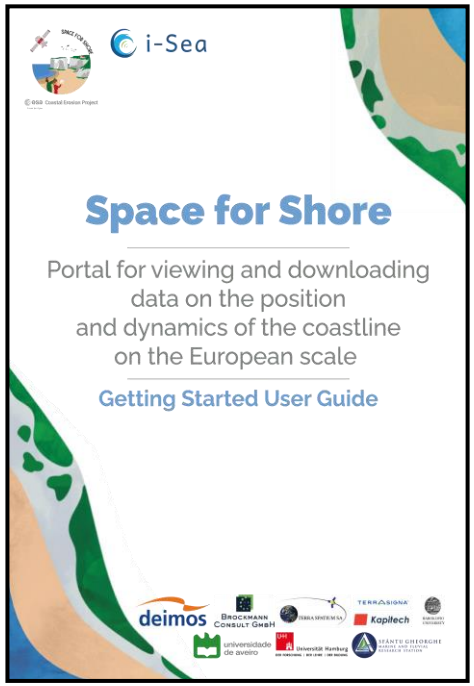
Must be interpreted considering the analysis period: short/medium/long term hazard. Can be adapted and refined with updated and/or more accurate databases.

The weight given to each issue can be modified according to the user's priorities. The land use database can be replaced by more local data.

How to access data

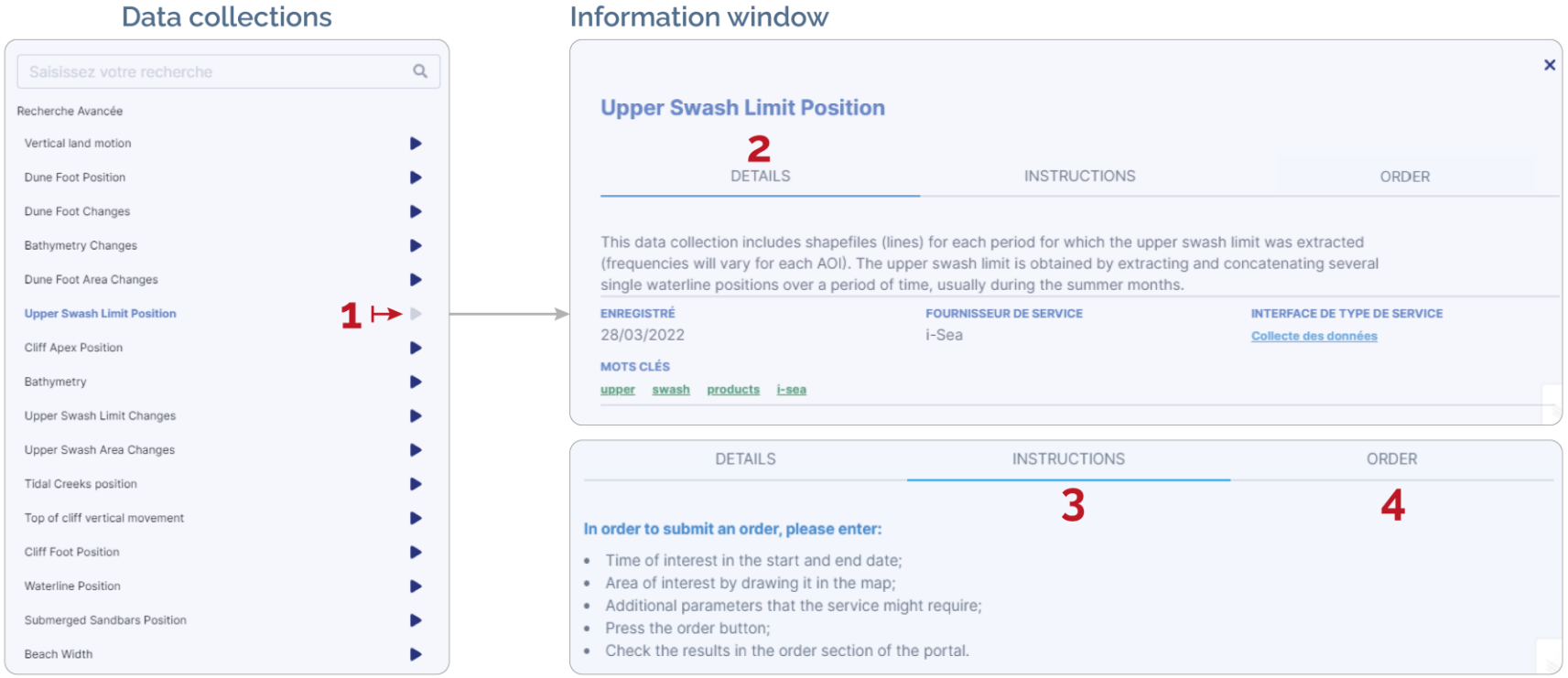
Dedicated geoportal





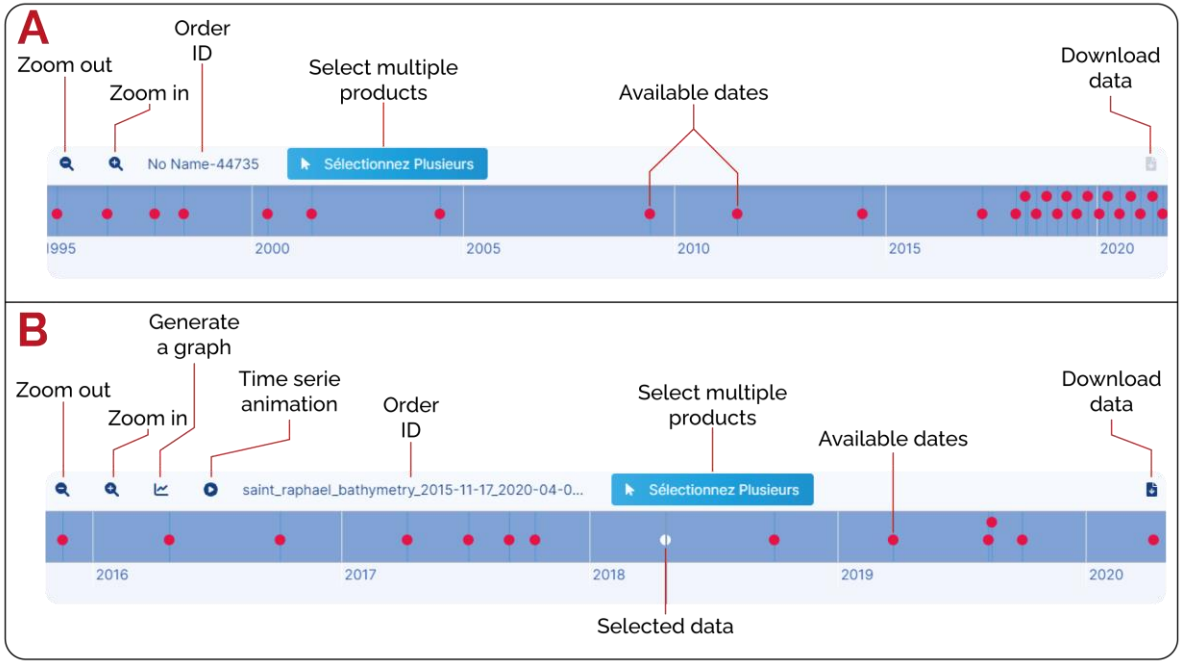
How to access data

- Data collections: one per product type (**1**)
- For each data collection : a simple description is provided (**2**)
- At any time: the end user can access the instructions (**3**) to consult the data (**4**)



How to access data

- An interactive and intuitive timeline that allows you to see at a glance all available dates for a given product. (**A**)
- Multiple products can be displayed at the same time to visualise changes
- For the bathymetry product: creation of graphs and temporal animations (**B**)



Pop-up information boxes for all products