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ESA Coastal Erosion Project: User Requirement Document

Coastal Resilience and Geohazards Programme

Technical Report CR/19/055

BRITISH GEOLOGICAL SURVEY

Coastal Resilience and Geohazards Programme

TECHNICAL REPORT CR/19/055

ESA Coastal Erosion Project: User Requirement Document

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1.0	27/08/2019	Consolidated end-user requirements & synthesis added	Project Partners

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Foreword

This is the User Requirement Document (URD) for the Coastal Erosion Project (BGS ref. NEE6695R) within the Science for Society slice of the 5th Earth Observation Envelope Programme (EOEP-5) run by the European Space Agency (ESA) and written by the Coastal Change From Space team. It contains a detailed specification of the user requirements, a synthesis of all requirements and is considered the primary input for all engineering tasks of the project.

The URD contains individual URDs for each one of the enrolled end-user organizations (British Geological Survey (BGS), Geological Survey Ireland (GSI), Subdirección General para la Protección de la Costa (SGPC) of the Ministerio para la Transición Ecológica (MITECO) and ARCTUS) and additional requirements from other end-users organized per country (UK, Republic of Ireland, Spain, Canada).

BGS member of staff, Dr Andres Payo has been in charge of compiling and synthesizing all end-user requirements into a standardized format and writing this report, while Dr Michael A. Ellis has reviewed and approved the final version of this document. The main contributors from each one of the enrolled end-users organization are: Dr. Xavier Monteys (GSI), Dr Jara Martinez Sanchez (Environmental Hydraulics Institute - Universidad de Cantabria, IHCantabria), Thomas Jaegler (ARCTUS).

The individual URD per end-user, the synthesis of all requirements described in this report combined with the critical analysis performed by the service providers (ARGANS Ltd, ISARDSAT and adwäisEO) complete the Requirement Baseline Document (RB) that shall be considered the primary input of all the engineering tasks of the project.

This report is the version 1 of the URD delivered to ESA on 27th August 2019.

Acknowledgements

In addition to the BGS staff acknowledged in the Foreword, Luke B. Bateson, Alessandro Novellino and Hussain Ekbal have contributed to the description of the BGS requirements included in this report.

In addition to the GSI staff acknowledged in the Foreword, Silvia Caloca and Ronan O'Toole have contributed to the description of the GSI requirements included in this report.

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In addition to the ARCTUS staff acknowledged in the Foreword, Thomas Jaegler, Steeve Dugas, Christian Fraser and Pascal Bernatchez have contributed to the description of the ARCTUS requirements included in this report.

The authors would like to thank Olivier Arino as the ESA technical officer in charge of this project.

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Summary

This is the User Requirement Document (URD) for the Coastal Erosion Project within the Science for Society slice of the 5th Earth Observation Envelope Programme (EOEP-5) run by the European Space Agency (ESA) and written by the Coastal Change From Space team. It contains a detailed specification of the user requirements and is considered the primary input for all engineering tasks of the project.

The URD contains individual URDs for each one of the champion end-user organizations (British Geological Survey (BGS), Geological Survey Ireland (GSI), IHCantabria and ARCTUS). This document also include a synthesis of all requirements.

All champion user organization has expressed interest on **products that represent the coastal change over time of different observable geometries (1D, 2D and 3D)** for different purposes with a list of the following salient attributes;

- **Clear shift from shoreline (1D) products to space (2D) and volume (3D) products**. It is interesting to notice that, while end-users are still interested on shoreline indicators of coastal change (35% of products are1D), there is an interest shift to area (24% of products are 2D) and most evident towards volume products (41% of products are 3D). This shift was expected as the coastal stakeholder community is on the agreement that any policy for coastal erosion should increase coastal resilience by restoring the sediment balance and providing space for coastal processes (EUROSION, 2004).
- **Spatial scope limited to the coastal zone but end users have interests beyond coastal zone**. Following from the previous point, it was clear that while the shoreline indicators are well within the coastal zone, some of the volume products, such as the bathymetries, are of interest for the coastal stakeholder in charge of ICZM of areas further offshore. For example, BGS is supporting the offshore wind industry that is developing on the shallow continental shelf of the Dogger Bank region [1] by interpreting bathymetry and subsurface data. Due to the cost of covering the whole region of the Dogger Bank (i.e. about the size of greater London) with traditional marine bathymetric surveys, developers focus their resources to measure bathymetry at locations where there is potential for installing wind turbines and not at the edges of the banks where scientists can extract useful information. Satellite-derived bathymetry could potentially provide bathymetric data in a cost effective way in the latter areas. Coastal erosion within the coastal zone has been identified by coastal stakeholders worldwide as an issue that needs urgent attention, and the consulted champion user organization agreed on limiting the spatial scope of the products requirements to the coastal zone.
- **Constraints imposed by non-satellite derived shoreline indicators on the preferred shoreline indicators requirements.** As noticed by [2] more than ten years ago, datum-based shoreline indicator provides a more objective detection technique than proxy-based shoreline indicators and as Topo-Bathymetric Digital Elevation Models become more accessible, it is likely to be the preferred shoreline indicator for ICZM and CFERM in the future but their applicability to the analysis of historical trends is more limited (i.e. historical mapped shorelines were mapped using visually discernible features to produce proxy-based shorelines). Both, datum-based and proxy-based shoreline indicators are required from the champion user organizations.
- **Interest of End-Users on listed products goes beyond the 25 years historical record.** All champion user organization expressed a common interest on using the *ca.* 25 years EO historical database to obtain a time series as long as possible for each EO product. The

value of long-time series comes from two perspective. First is the intrinsic value of actual change-data over as long a period as possible. Second is the necessity of long-time series to test, calibrate and use predictive modelling. Quantifying future coastal change in order to assess risk, for example, will necessarily rely on computational predictive models, and such models are only ever as good as the training data available to them. How many more years into the future the described products will be required was also discussed. This is relevant to define the years of interest for the service specification for units currently on operation (i.e. Sentinel 1 and Sentinel 2). ICZM and CFERM involves time horizons of 100 years and it is on the interest of all champion user organizations to be able to assess coastal change over a similar time span. Since EO data is covers only the last *ca.* 25 years of coastal change, it suggest that the products described here will be also required over the next 75 years (i.e. until 2095) until a complete 100 years EO derived product database becomes a reality. This has only minor consequences to the outcomes of this project but it is worthy to keep in mind that a data gap larger than 25 years still exists.

- **Coastal State Indicators are treated as a sub-category of 3D products.** Coastal State Indicators (CSI) other than shoreline indicators are considered here as a sub-category of the 3D products. A list of CSI has been included as within the Topo-Bathymetric Digital Elevation Model (TBDEM) product description (Table 8) because most of them can be derived from it. The fundamental difference between CSIs and 1D, 2D and 3D geometrical products is that geometrical products has either a long tradition of use (i.e. shoreline indicators) or surveyors has a mandate to monitor (i.e. elevation, bathymetry) while CSIs are often site and stakeholder specific and therefore more difficult to standardize. As many of the listed CSIs can be derived from a TBDEM, by including them as a sub-category of the 3D products we will ensure that will also be included in the critical analysis and feasibility study.
- Detailed specifications on geometrical accuracies of outputs **are aspirational requirements needs for the future, and the champion organizations expect to know of the feasibility**, considering results with; (i) **available EOs of the last 25 years** to assess an average erosion rate at the decadal time scales, (ii) **COPERNICUS and commercial higher resolution EOs of last 5 years** to monitor erosion and accretion for the management of the coastline by local authorities, (iii) **using state of the art sub-pixel resolution techniques** [3].

1 Introduction

The scope of the ESA Coastal Erosion project is the development & demonstration of innovative EO products that will be used by end-users in charge of monitoring (surveyors) and manage (coastal stakeholders) coastal erosion. The surveyors and coastal stakeholders consulted to elaborate this document are represented by four champion user organizations (BGS, GSI, MITECO and Government of Quebec). The interest of all champion users organizations represents the requirements of public and private surveyors as well as the requirement of Government Agencies, public and private entities in charge of both Integrated Coastal Zone Management (ICZM) and Coastal Flood and Erosion Risk Management (CFERM). To maximize the use of the outcomes of the Coastal Erosion Project, additional end-users on each of the champion user's organization countries (United Kingdom, Republic of Ireland, Quebec, Spain) has expressed their interest on contributing to the definition of the end-user requirements.

Figure 1.- Attendees to the Consolidation User Requirement Document workshop held IHCantabria, Santander, Spain on July the 8th 2019.

We have followed an iterative process to create an individual consolidated URD for each one of the champion user organizations. During the end user kick-off meeting on 3rd May 2019, the URD submitted with the project tender was reviewed and the items that required further details identified. The required steps to produce a consolidated URD by the project mid-term review (i.e. final version of URD) include the production of two versions of the URD as indicated in Table 1. The URD v1 is produced by consolidating and synthesizing the URD v0 submitted with the project tender and is limited to the URD of the champion user's organization. The URD v2 will be an extension of the previous one by including URD from the broader community for each of the four countries to which the champion users organizations belong to. A large number other end users has expressed their interest on expanding the product requirements described by the champion end-users presented in this document. The list of interested parties continues growing as this project evolves. At the time of writing this document we have a received an expression of interest from institutions from the following country partners; **UK** (Environment Agency, UK Hydrographic Office, Coastal Partnership East, WSP Group, HR Wallingford, Univ. Southampton, Univ. Plymouth, Univ. Cardiff, National Oceanographic Centre, Coastal Channel

Observatory, Univ. of Liverpool, Univ. of Cambridge, Birbeck Univ., Edimburgh Univ., Centre for Environment, Fisheries and Aquaculture Science, Scottish Environmental Protection Agency); **Republic of Ireland** (Office of Public Works (OPW), Ordnance Survey Ireland (OSI), Environmental Protection Agency (EPA)); **Spain** (Instituto Geográfico Nacional, IGN; Instituto Hidrográfico de la Marina, IHM; Autoridad Portuaria de Barcelona; Maritime Engineering Laboratory, LIM/UPC; Universidad Politécnica de Valencia, UPV; AZTI Tecnalia). On version 2 of the URD, the project partners will incorporate the broader end users requirements and update URD and synthesis

This document is the URD v1 and it is structured in three main sections. After this introduction, a synthesis of all the user requirement collected from the champion user organizations are presented. In the third section, a proposed way forward to consult with the broader end user community on each one of the four countries involved. The requirements details of each champion user organization has been completed following the format shown in Appendix 1 (User Requirement Template) and are shown in Appendix 2 (Champion user organization User Requirement).

Table 1 Description of the intermediate deliverables required to produce the final version of the URD by the mid-term review.

Key deliverables	Date	Description/Actions
URD v0	3/07/2018	First draft of URD submitted with tender
URD v1††	27/08/19 (KO† + 4m)	Project partners to complete all items shown in URD template Appendix 1 and synthesis.
URD v2	03/11/19 (KO†+ 7m)	Project partners to incorporate broader end users requirements and update URD and synthesis
Mid Term Review	03/01/20 (KO†+9m)	Final version of URD

† KO: project Kick Off 03/04/2019

††This document

2 Synthesis of end user requirements

2.1 OVERVIEW

Table 2 list all the 17 EO products description tables provided by the four champion user organizations. The details of each product description can be found on the different tables included on Appendix 2 and inserted as hyperlinks on Table 2. All champion user organization has expressed interest on **products that represent the coastal change over time of different observable geometries (1D, 2D and 3D)** for different purposes. The commonalities and differences among products is discussed in detail later in this section but here we enumerate a list of salient attributes of the products descriptions as a whole;

- **Clear shift from shoreline (1D) products to space (2D) and volume (3D) products**. It is interesting to notice that, while end-users are still interested on shoreline indicators of coastal change (35% of products are1D), there is an interest shift to area (24% of products are 2D) and most evident towards volume products (41% of products are 3D). This shift was expected as the coastal stakeholder community is on the agreement that any policy for coastal erosion should increase coastal resilience by restoring the sediment balance and providing space for coastal processes (EUROSION, 2004).
- **Spatial scope limited to the coastal zone but end users has interest beyond coastal zone**. Following from the previous point, it was clear that while the shoreline indicators are well within the coastal zone some of the volume products, such as the bathymetries, are of interest for the coastal stakeholder in charge of ICZM of areas further offshore. For example, BGS is supporting the offshore wind industry that is developing on the shallow continental shelf of the Dogger Bank region [1] by interpreting bathymetry and subsurface data. Due to the cost of covering the whole region of the Dogger Bank (i.e. about the size of greater London) with traditional marine bathymetric surveys, developers focus their resources to measure bathymetry at locations where there is potential for installing wind turbines and not at the edges of the banks were scientist can extract more useful information. Satellite derived bathymetry could potentially provide bathymetric data in a cost effective way on the latter areas. Since coastal erosion within the coastal zone has been identified by coastal stakeholders worldwide as an issue that need urgent attention, the consulted champion user organization agreed on limiting the spatial scope of the products requirements to the coastal zone.
- **Constrains imposed by non-satellite derived shoreline indicators on the preferred shoreline indicators requirements.** As noticed by Boak and Turner [2] more than ten years ago, the datum-based shoreline indicator provides a more objective detection technique than the proxy-based shoreline indicators. As Topo-Bathymetric Digital Elevation Models become more accessible, it is likely to be the preferred shoreline indicator for ICZM and CFERM in the future, but their applicability to the analysis of historical trends is more limited (i.e. historical mapped shorelines were mapped using visually discernible features to produce proxy-based shorelines). As a result, both datum-based and proxy-based shoreline indicators are required from the champion user organizations.
- **Interest of End-Users on listed products goes beyond the 25 years historical record.** All champion user organizations expressed a common interest on using the *ca.* 25 years EO historical database to obtain a time series as long as possible for each EO product. The value of long-time series comes from two perspective. First is the intrinsic value of actual change-data over as long a period as possible. Second is the necessity of long-time series to test, calibrate and use predictive modelling. Quantifying future coastal change in order to assess risk, for example, will necessarily rely on computational predictive models, and such models are only ever as good as the training data available to them. How many more years into the future the described products will be required was also discussed. This is

relevant to define the years of interest for the service specification for units currently on operation (i.e. Sentinel 1 and Sentinel 2). ICZM and CFERM involve time horizons of 100 years and it is in the interest of all champion user organizations to be able to assess coastal change over a similar time span. Because EO data cover only the last *ca.* 25 years of coastal change, it is suggested here that the products described here will also be required over the next 75 years (i.e. until 2095) until a complete 100 years EO derived product database becomes a reality. This has only minor consequences to the outcomes of this project but it is worthwhile to keep in mind that a data gap larger than 25 years still exists.

- **Coastal State Indicators are treated as a sub-category of 3D products.** Coastal State Indicators (CSI) other than shoreline indicators are considered here as a sub-category of the 3D products. A list of CSI has been included as within the Topo-Bathymetric Digital Elevation Model (TBDEM) product description (Table 8) because most of them can be derived from it. The fundamental difference between CSIs and 1D, 2D and 3D geometrical products is that geometrical products have either a long tradition of use (i.e. shoreline indicators) or surveyors have a mandate to monitor (i.e. elevation, bathymetry) while CSIs are often site and stakeholder specific and therefore more difficult to standardize. As many of the listed CSIs can be derived from a TBDEM, by including them as a sub-category of the 3D products we will ensure that will also be included in the critical analysis and feasibility study.
- Detailed specifications on geometrical accuracies of outputs **are aspirational requirements needs for the future, and the champion organizations expect to know of the feasibility**, considering results with; (i) **available EOs of the last 25 years** to assess an average erosion rate at the decadal time scales, (ii) **COPERNICUS and commercial higher resolution EOs of last 5 years** to monitor erosion and accretion for the management of the coastline by local authorities, (iii) **using state of the art sub-pixel resolution techniques** [3].

Table 2. EO products name, champion user organization, link to table with detailed description and type of product.

Name	Champion	Details	Type
Proxy-based Tidelines	BGS	Table 6	1D
Datum-based Tidelines	BGS	Table 7	1D
Topo-Bathymetric Digital Elevation Models	BGS	Table 8	3D
Habitat map	BGS	Table 9	2D
Bathymetric change in the nearshore	GSI	Table 13	3D
Coastal DEM	GSI	Table 14	3D
Waterlines to shorelines	GSI	Table 15	1D
Elevation transects	GSI	Table 16	3D
Land cover changes	GSI	Table 17	2D
Vegetation line	GSI	Table 18	1D
Bathymetry changes on beaches	MITECO	Table 26	3D
Shoreline changes on beaches	MITECO	Table 27	1D
Land cover changes	MITECO	Table 28	2D
Nearshore bathymetry	GoQ	Table 32	3D
Sediment volume changes	GoQ	Table 33	3D
Shoreline/Waterline	GoQ	Table 34	1D
Land-Use and Land-Cover and habitat maps	GoQ	Table 35	2D

GoQ: Government of Quebec; 1D: One dimensional geometries confined to points on a line; 2D: Two dimensional geometries expressed as flat planes with no depth; 3D: Three dimensional geometries that describes objects with volume

2.2 1D: WATERLINES AND SHORELINES

SUMMARY

- End-users are interested in 1D products of type shoreline indicators (SI) for both legal interest and to monitor standard of protection change over time.
- These type includes; proxy-based (PSI) and datum-based (DSI) shoreline indicators
- PSI has been used historically (i.e. previous Satellite data era) and impose some restrictions on which proxies are used as SI
- Proxies used for PSI varies with country partners and has changed over time
- Tidal level used for DSI also varies with country partners and has changed over time
- Landward Extent of SI within estuarine environments varies with end user duties
- All end-users have expressed interest in analysing the full historical ca. 25 years archive of satellite data and also exploring what is feasible with higher accuracy satellite data

BENEFITS

- SI is of legal interest and also used as an indicator of standard of protection from coastal flooding and coastal erosion threats.
- This product allows management authorities in flood and coastal erosion risk to create a coastal erosion baseline from which other decisions can be made and priorities flow.
- Will allow coastal engineering practitioner and research community to better understand process of change and validate conceptual and numerical models used to assess and predict coastal change and adaptation options.
- To assess the efficacy of the back-pass of sediments performed regularly by Port Authorities
- To improve understanding of coastal morphodynamics at two timescales: interannual evolution and short-term response to storms. This knowledge is the first step towards the development of an action plan targeting both the regular maintenance works and the provision of emergency works.
- To inform the strategies for the coastal protection
- To inform their management decision and to design regular maintenance and emergency works

2.3 2D: LAND USE, LAND COVER AND HABITATS MAPS

SUMMARY

- End-users are interested in 2D products of type land use and land cover and habitat mapping
- Land use and land cover maps are required to characterize the receptor for standard coastal risk management practices
- Habitat mapping is required to monitor the implementation of wetland restoration projects. Wetland restoration is becoming a common adaptation option to reduce risk of coastal flooding and coastal erosion
- Classes required for land use, land cover and habitat mapping varies among end-users
- The spatial scope also varies with end-users' duties and responsibilities

BENEFITS

- In UK, habitat creation achieved as part of coastal managed realignment schemes has been estimated to provide environmental benefits valued at between £680 and £2,500 per hectare, including carbon storage benefits. Furthermore, the Climate Change Committee (2013)1 advised that 6200 ha of coastal habitat created nationally by 2030 (costing £10-15M per annum) would save £180-£380M in capital and maintenance costs on coastal flood and erosion management over the long-term when compared to the cost of replacing/maintaining hard defences.
- Monitoring change of land cover and land use will allow to assess any change on the vulnerability to coastal flooding and coastal erosion
- To assess the efficacy as a coastal risk management of replacing hard structures by soft engineering and revegetation of the backshore
- To inform their management decision and to design regular maintenance and emergency works

2.4 3D: TOPO BATHYMETRIC DIGITAL ELEVATION MODELS & COASTAL STATE INDICATORS

SUMMARY

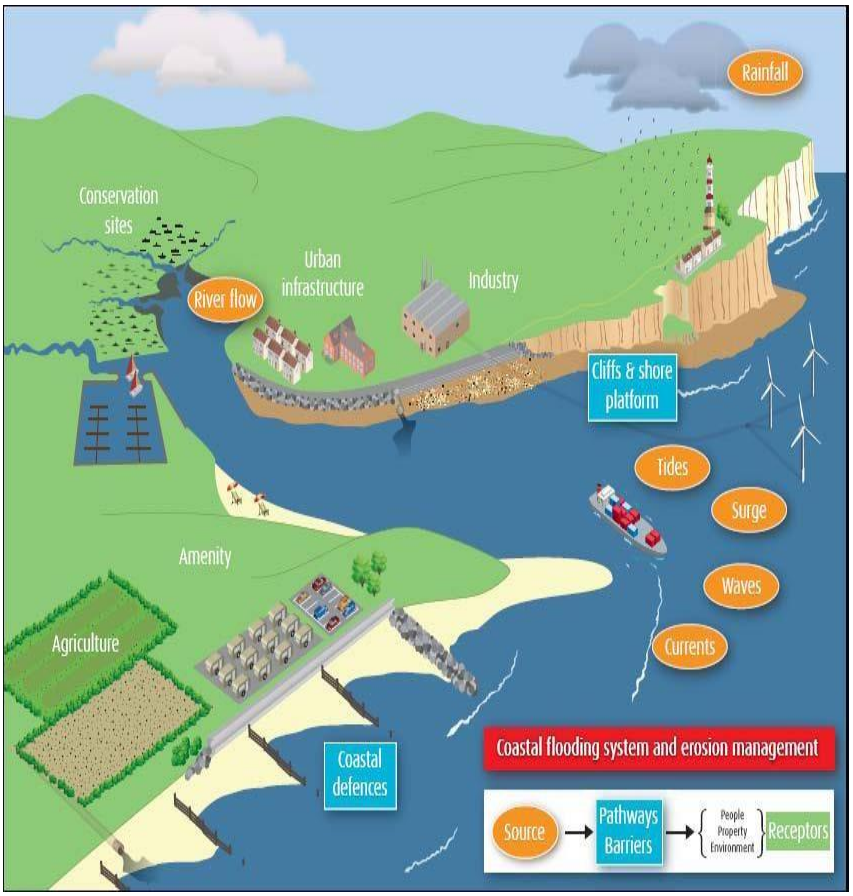
- End-users are interested in 3D products of type Topo-Bathy-metric Digital Elevation (TBDEM) Models, elevation transects (ET) and Coastal State Indicators (CSI)
- TBDEM is a raster product, ET is a vector product and CSI are a combination of vector and raster products
- TBDEMs are required to produce Datum Based Shoreline Indicators and also assess volumetric sediment change
- ET contains the elevation along transects perpendicular to the coastline from the backshore to the foreshore
- CSIs requirements varies among end users and can be derived from 1D, 2D and 3D products

BENEFITS

- Assess geomorphic change and volumes of sediment eroded and deposited by subtraction of two independent DTM surfaces to produce a DTM of Difference (DoD), with each grid cell value representing a measure of the vertical elevation difference
- Monitoring dredging activity and environmental awareness
- Monitoring an active coastal erosion in a urban area
- Monitoring estuary dynamics
- Monitoring coastal erosion, sea level and submerged landscapes
- Complement monthly subaerial beach profiles along the alignment of a gas pipeline buried on the beach towards a proactive management that prevents the exposure of the pipeline
- Assess the efficacy of sand extraction actions for navigational purposes and to estimate the sedimentation rates in the beach in order to plan new actions

COASTAL STATE INDICATORS

- Coastal state indicators (CSIs) are a reduced set of measurable parameters used by coastal managers as benchmarks to support management processes
- They are designed to provide evidence of trajectories of change and to inform timely management interventions [4]
- The coast yields multiple benefits to coastal inhabitants, and depending on their responsibilities, coastal managers will be interested in different sub-sets of CSIs
- CSIs are often framed within Source-Pathway-Receptor (SPR) or similar risk analysis frameworks [5] (Figure 2)
- Coastal geomorphology is a crucial component, representing the pathway that modifies the severity of marine hazards (e.g. surges, extreme waves) as they are experienced by 'receptors' on the coast
- Figure 2 summarizes a list of CSIs that represent the pathway of different coastal environments and can be derived from the 1D, 2D and 3D products described in this document



CSI*	Quantity represented	Spatial separation	Time between measurements	Case Study
Dune strength	SoP for storm	250 m	5 years	Dutch coast
Barrier width	SoP for storm	180 m	1 month	Pevensey, UK
Total barrier volume	SoP for storm	180 m	1 month	Pevensey, UK
Backshore width	SoP for storm	Mean 1.75 km	1 year	Black Sea
Dune zone width	SoP for storm	Mean 1.75 km	1 year	Black Sea
Dune zone height	SoP for storm	Mean 1.75 km	1 year	Black Sea
Momentary coastline	Position & boundary condition for SoP	250 m	1 year	Dutch coast
Beach width	Boundary condition for SoP of hard defence	100 m	6 months	Costa Brava, Spain
Barrier crest position	Position	180 m	1 month	Pevensey, UK
Shoreline position	Position	Few m	4 to 5 years	Black Sea
Shoreline position	Position	≤ 500 m	1 year	Hel peninsula, Poland
Coastline position	Perception of safety	Irregular	Event-driven	Inch Strand, Ireland
Coastal foundation	Rise with sea level	250m	Several years	Dutch coast
Shoreface volume	Flood and coastal erosion risk	500m	4 years	Hel peninsula, Poland
Coastal slope	Flood and coastal erosion risk	Mean 1.75km	4 to 5 years	Black Sea

SoP: standard of protection

Figure 2. Illustrative example of the sources, pathways and receptors for coastal flooding and coastal erosion (top) and examples of CSIs (bottom)

Appendix 1 User requirements document template

Appendix 1 (i.e. Annex A in SOW) aims at providing the end-user organizations with a User Requirements Document (URD) template to describe their service and products requirements. The end-users are required to fill all the different sections in the URD as accurately and thoroughly as possible. The level of informative details of the URD will have a direct impact on the quality of the project.

END-USER-ORGANIZATION PRESENTATION AND EXPECTATIONS

In this section a description of the end-user organization is required. The end-user is also requested to provide information about their activities related to the project as well as an overview of their current practices in the field. In addition, the users are requested to provide an insight into their expectations from participating to the project.

End-user organization

1. End-User Organization	
Name:	*Name of the organization*
Type of organization:	*Type of organization (e.g., governmental agency, intergovernmental organization, non-governmental organization, private company, etc.);*
Description:	*Brief description of the organization's activities related to the project;*
Department/Division/Sec ti on/Unit	*Brief description of the specific unit, which will be involved in the project, and its role in relation to the project scope.*
Website	*Organization website*
Contact person	*Contact person, position of the contract person within the organization and contact data (postal address, email, telephone, fax).*

Requirements Overview

2. Requirements Overview	
Description of the requested service:	*Provide a brief description of the proposed service and products (a detailed description of the service will be provided later) and the justification of that service (e.g., legal obligation, public duty, commercial interest, etc.)*
Current Practices:	*Provide a brief description of the current practices related to the proposed service (for example how is the current information acquired, with what accuracy, at what cost, etc.).*
Motivationand expectation:	*Provide a brief description of the motivation and expectation for the participation as end-user to the proposed project*

SERVICE AND PRODUCT SPECIFICATIONS

In this section, the service and the service products to be developed by the project should be specified. The section shall be divided in two parts:

- A description of the geographical areas of interest;
- A description of the information products required for each of these areas.

Area of interest and service demonstration AOI

In this section, the end-user is requested to indicate both:

- The operational area of interest, i.e. the area that he would like covered by an operational service and;
- The demonstration area of interest also called pilot area of interest, i.e. the area that he would like covered by the project.

In the event that multiple geographical areas with different characteristics are sought, the end-user is requested to include one table for each geographical area.

3. Area of Interest	
Name:	*Name of the area of interest and/or of the service demonstration area.*
Type:	*Type of geographical area (e.g. administrative region, river basin/watershed, protected area, coastal area, etc.)*
Geographical coordinates and size of area of interest:	*Latitude:* *Longitude: Size (km2):*
Geographical coordinates and size of service demonstration area:	*Latitude:* *Longitude:* *Size (km2):*
Description:	*Brief description of the area of interest and of the service demonstration area.*
Problems/issues:	*If relevant, the end-user should list the main problems or threats to the area related to the project and the service case under consideration*

User organizations:	*User-organizations that are concerned by the service/products over the proposed AOI and that will/could be involved in the project.*
Available data:	*List of the satellite data, airborne data (e.g. aerial photos), in situ data, ancillary data, support data and other relevant information available for this AOI.*

Description of the required products

In this section, the end-user is requested to describe each of the required service and products.

4.(i) Description of product no. i	
General Description	
General service/product description:	*General description of the service and of the information products*
Uses and benefits:	*Specific use the end-user will make of the required information service and products, and potential benefits that the service/products would provide.*
Product Specifications	
Spatial scale:	*e.g. 1:25,000, 1:50,00, etc.* *(only relevant for mapping products)*
Minimum cell size: (or mapping unit)	*e.g. 10mx10m, 0.1ha, etc.* *(only relevant for mapping products)*
Information layers:	*Detailed description of the information products required.*
Product format:	*Requested product format for the various information layers.* *For example, in the case of a land-cover product around a protected area:* o *Raster files in GeoTiff format for the land-cover layer supported by a metadata file including ancillary information on accuracy, data used, etc;* o *Vector format in shapefile format for the additional information layers;*
Software platform compatibility:	*Compatibility with existing software products.* *For example, the products should be compatible with the following commercial and open source GIS: ArcGIS 10.2.1, MapInfo 12.0, GRASS GIS 7, Quantum GIS 2.0*

Product accuracy:	*Requested thematic and geometrical accuracy.* *For example, an overall 80% thematic accuracy and 10 m geometrical accuracy for land-cover map; +/- 1.5 m/s for a wind speed prediction; 15 m vertical and 10 m horizontal relative accuracies for DEM, etc.*
Service Specifications	
Years of interest:	*For service/products required in specific years: e.g. 1990, 2000, 2010, 2020.*

Temporal range:	*For service/products involving a temporal range: e.g. change detection between 1990 and 2020.*
Updating frequency:	*For service/products involving a periodic delivery or updating: e.g., Yearly acquisitions of water surface temperature; 12-hourly predictions of wave height*
Temporal baseline:	*For service/products that require a year of reference: e.g., 2004.*
Ordering:	*e.g. Web based ordering system.*
Delivery time required:	*If some constraints in the delivery time are required, e.g. within months after ordering.*
Delivery format:	*e.g. Web-based (http), ftp, CD-ROM/DVD.*
Validation data	
Available at the end-user's premises:	*For example, measured water levels at 80 points inside area of interest yearly from 1985; collected crop type in agricultural survey in 2001 for 300 farmers inside area of interest*
Available elsewhere:	*For example:* o *digital, orthorectified aerial photos from 1998 covering half of the area of interest;* o *user has access to continuous measurements of wave height from five buoys in the area* o *etc.*
Planned collection and when:	*For example, new survey planned summer 2015 covering the area of interest.*

Appendix 2 Requirements from champion user organizations

BRITISH GEOLOGICAL SURVEY (BGS)

Table 3. End-User Organization: BGS

1. End-User Organization	
Name:	British Geological Survey
Type of organization:	Governmental agency
Description:	BGS is the UK's premier provider of objective and authoritative geoscientific data, information and knowledge to help society to: - use its natural resources responsibly - manage environmental change - be resilient to environmental hazards BGS provides expert services and impartial advice in all areas of geoscience. Our client base is drawn from the public and private sectors both in the UK and internationally.
Department/Division/Section/ Unit	Three departments involved this project under the Catchment Science and Observatories directorate, which will coordinate and integrate activities under all other directorates. (1) Marine Geoscience directorate/Continental Shelf Geoscience (translation of raw data into usable information) (2) Earth Hazards, Observatories (in charge of the validation) (3) Geoanalytics and Modelling (design of the derived products).
Website	www.bgs.ac.uk
Contact person	**Dr. Michael A. Ellis** Head of Catchment Science and Observatories Address: British Geological Survey, Environmental Science Centre, Nicker Hill, Keyworth, Nottingham, NG12 5GG Tel: +44 0115 936 3356 Email: mich3@bgs.ac.uk **Dr Andres Payo** Coastal Resilience and Geohazard researcher Address: British Geological Survey, Environmental Science Centre, Nicker Hill, Keyworth, Nottingham, NG12 5GG Tel: +44 (0)115 936 3103 Email: agarcia@bgs.ac.uk

Table 4. Requirements Overview: BGS

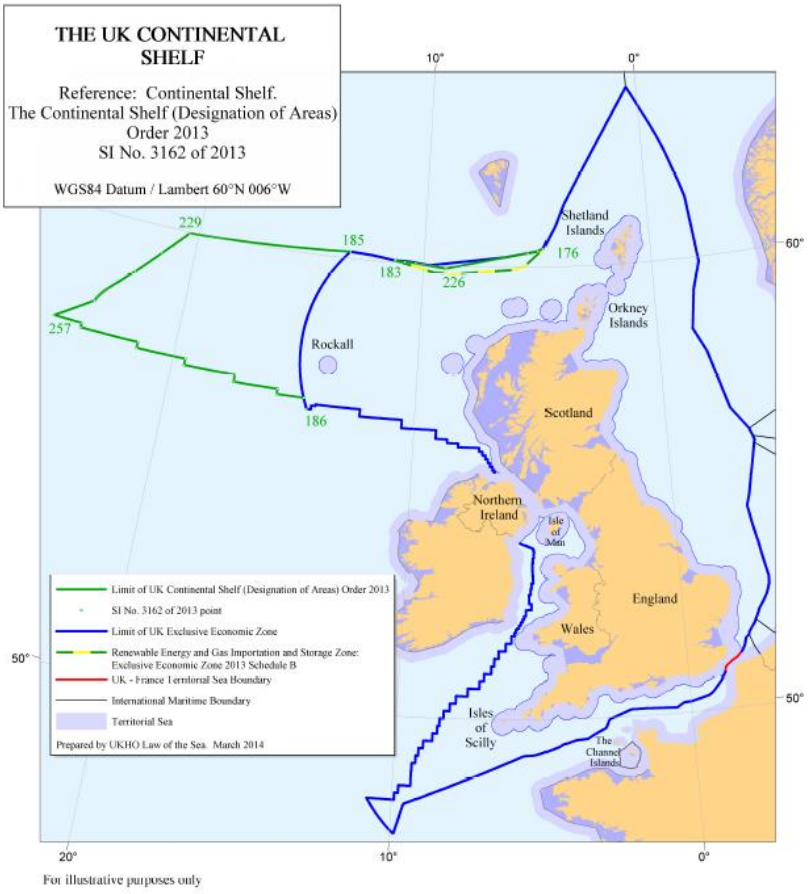
2. Requirements Overview

Description of the requested service:	The expected service and products can be categorized into three major themes: (1) Facilitate estuaries and tidal inlets morphometric analysis (2) Regional representation of the backshore elevation changes (cliff and intertidal beach) and foreshore (submerged beach, platform cut) (3) Filling the bathymetry data gaps on the shallow nearshore region that is always submerged with depth ranges between 0m to 10m and of the margins of offshore sandbanks
Current Practices:	(1) It was recognised almost 20 years ago that an adequate understanding of estuarine geomorphology is essential for the development of appropriate flood risk and nature conservation management policies, and for assessment of the likely consequences of future climate change (Pye & Blott, 2014). Since that time a substantial amount of research has been undertaken on estuaries, including Phases 1 and 2 of the Estuaries Research Programme (ERP1 and ERP2), and several new analytical tools have been developed. Morphometric information contained in the most recent version of the Estuaries Database (Manning, 2012) is still incomplete and places a significant limitation on attempts to develop models which explain and predict relationships between form and process in different estuaries. Although new bathymetric and hydrodynamic process data is now being collected within some UK estuaries as part of the regional strategic monitoring programmes and estuary flood risk management strategy studies, many gaps remain and need to be filled in order to allow adequate quantification of active estuary morphometry and to provide early warning of likely future change. (2) The current version of the Coastal Vulnerability Index (CVI) consists of data layers in GIS format that identify areas susceptible to flooding and coastal erosion for mainland Great Britain within 1km of the coast. This data has been produced by geologists including engineering, coastal and information specialists at the British Geological Survey. The two data sets that assess coastal erosion are called the Backshore and Foreshore layer respectively. The Backshore layer has been derived through an erosion susceptibility assessment and it considers a number of geological engineering properties of cliff sections around the GB coastline using the discontinuities and excavatability datasets (part of the BGS Civils data suite), and the BGS Permeability dataset. A scoring system was derived based on a range of geological and engineering properties and applied to each rock layer within the cliff stratigraphy. These scores were summed to produce an overall score of erosion susceptibility. The Foreshore dataset contains the spatial extent of coastal geomorphological features (beaches, tidal flat deposits, saltmarshes or wave-cut platforms or any combination of these) that would potentially act to dissipate wave energy before it meets the cliff. These features would effectively "buffer" the cliff or backshore, potentially decreasing rates of erosion from waves and currents. (3) The region between the low water mark and 10 m water depth is often referred as the white ribbon due the lack of data at the interface between inland topography and offshore bathymetry (i.e. represented as a white ribbon on the maps). Wind farms have being developed around the numerous shallow sand banks on the UK continental shelf (i.e. crest of sand banks depth varies from 1m to 20m).
Motivation and expectation:	(1) Fill the remaining gaps on estuarine morphology that will allow adequate quantification of active estuary morphometry and to provide early warning of likely future change. In UK, there is a lack of clarity and consistency regarding the definition of estuaries and the morphometric parameters which should be measured and monitored to provide evidence of change. Deriving tidal boundaries from the water/land boundary using satellite images is challenging on estuarine areas where tidal regime is complex and tide times can vary a great deal over short distances (UKGEOS, 2018). There are a number of other estuarine features that are

	informative of estuarine behaviour that could be extracted from satellite imageries. This features are the Channel length along the thalweg (a line connecting the lowest points of successive cross-sections along the course of a valley or river), estuary width at different locations and tidal phases (mouth, half estuary), maximum and minimum depth, cross sectional area at mouth and half estuary, estuary plan area. (2) The Backshore and the Foreshore layers could potentially be enhanced by remote sensing data. For the Backshore layer, which represents the cliff, repeated surveys along the cliff line could help to identify areas of active land sliding that haven't currently been captured in the BGS National Landslides Database. Repeated surveys could also be of benefit in determining and monitoring beach gradient. This could be especially important if it could be captured following storm events. (3) The capacity of mapping synoptically and frequently (~1per month) the bathymetry between ~5 to 10m has the potential to fill our current understanding on an important region related with coastal erosion and offshore energy development. Other end users (i.e. Local Authorities, Environment Agency) will benefit by having better estimates of net sediment gains and losses (currently limited to the lower tide level) which will might lead to a better informed decisions. In collaboration with research institutions, new coastal state indicators could be derived. For example, combining the LIDAR and beach profile measurements with the foreshore slope changes will provide an almost close budget of nearshore sediment transport. Beach recovery is a slower and less understood process than beach erosion. Repeated bathymetry measurements over period of months to year will help to better understand the dynamics of beach recovery. Offshore energy developers will benefit by having a better understanding of sand banks mobility. Sand banks mobility is also important for coastal erosion (i.e. sand banks protect coast from erosion as natural submerged breakwaters).

Table 5. Area of Interest: BGS

3. Area of Interest	
Name:	United Kingdom including Continental Shelf
Type:	Administrative region.
Geographical coordinates and size of area of interest:	Latitude: 51°30′N (London) Longitude: 0°7′W (London) Size (km^2): 1,125M; out of which 22% is inland and 78% is offshore
Geographical coordinates and size of service demonstration area:	**Area #1** Name: Great Britain & Northern Ireland Latitude: Longitude: Size (km^2): 242,495 (209,331 Great Britain + 14,130 Northern Ireland) **Area #2** Name: UK Continental Shelf

	Latitude: Longitude: Size (km^2): 882,900  For illustrative purposes only
Description:	**Area 1: Great Britain and Northern Ireland** The United Kingdom includes the island of Great Britain, the north-eastern part of the island of Ireland, and many smaller islands. Northern Ireland is the only part of the United Kingdom that shares a land border with another sovereign state, the Republic of Ireland. Apart from this land border, the United Kingdom is surrounded by the Atlantic Ocean, with the North Sea to the east, the English Channel to the south and the Celtic Sea to the south-west, giving it the 16th-longest coastline in the world with ca. 12,429 km (according to "The World Factbook"). **Area 2: UK Continental Shelf** The UK Continental Shelf (UKCS) is the region of waters surrounding the United Kingdom, in which the country has mineral rights. The UK continental shelf includes parts of the North Sea, the North Atlantic, the Irish Sea and the English Channel; the area includes large resources of oil and gas. The UK continental shelf is bordered by Norway, Denmark, Germany, the Netherlands, Belgium, France, and the Republic of Ireland. A median line, setting out the domains of each of these nations was established by mutual agreement between them, see the Continental Shelf Act 1964. While the depth of the UK Continental Shelf varies significantly, the shallowness of the North

	Sea at an average depth of 95m has facilitated the development of offshore oil drilling and wind farms.
Problems/issues:	**Area 1** The UK Adaptation Subcommittee of the Committee on Climate Change has recently identified flooding and coastal change risks to communities, business and infrastructure as the top priority area where more action is urgently needed. The length of Great Britain coastline and Northern Ireland is 12,400 km, out of which 2,500 km are at risk of flooding or coastal erosion, putting 4 million people at risk of coastal flooding and £10bn of assets. In a new report, 'Managing the coast in a changing climate' (2018), the Committee says that these threats will increase in the future. Only in England, it is estimated that by 2100, 1,600 km of major roads, 650 km of railway line, 92 railway stations and 55 historic landfill sites are at risk of coastal flooding or erosion. **Area 2**
User organizations:	**Area 1** In UK, management of the coast does not lie within the remit of a single authority or organization. Flooding is a devolved matter and each nation has different systems and policies in place to manage flooding and coastal erosion risk; • In England, the Environment Agency (EA) has the strategic overview role for coastal and flooding issues to support coastal authorities, communities and other "stakeholders". Local authorities, Internal Drainage Boards (IDBs), the Environment Agency, and local communities work together to develop projects to reduce the risk of flooding and coastal erosion. • In Scotland, the Scottish Environment Protection Agency (SEPA) and responsible authorities to exercise their functions with a view to reducing overall flood risk. Responsible authorities include local authorities, Scottish Water and other public bodies designated by Scottish Ministers. • In Wales, the Welsh Government is responsible for developing flood and coastal risk management policy in Wales. It largely funds flood and coastal activities undertaken by operating authorities (including Natural Resources Wales, local authorities and IDBs) across Wales **Area 2** Responsibility for the mineral rights of the UKCS rests with the Oil and Gas Authority part of Department for Business, Energy and Industrial Strategy (BEIS), which awards licences to oil companies to produce hydrocarbons from specific areas and regulates how much they can produce over what period.
Available data:	List of the satellite data, airborne data (e.g. aerial photos), in situ data, ancillary data, support data and other relevant information available for this AOI.

Table 6. Product description BGS #1: Proxy-based Tidelines

Description of product no. 1	
General Description	**A proxy tideline (a physical feature taken to represent the shoreline) at different tidal elevations**
General service/product description:	We would like to be able to produce proxy tidelines that are consistent with tidelines mapped by the UK Ordnance Survey (OS) on the County Maps. Tidelines on County Series maps usually came from measured line surveys with offsets [1]. A proxy tideline (a physical feature taken to represent the shoreline) was surveyed. High tide lines were captured by one of two methods: 1. Objects were placed on the beach at the time of high water. The positions of the objects were surveyed and the surveyed points were joined to form the Mean High Water (MHW) or Mean Low Water (MLW) mark. 2. The mark left by high tide was surveyed. Winterbotham (1934) (ref in [1]) noted that high tide "generally leaves a clear mark … there is not much difficulty in surveying this line". Different nations within UK use different definitions of MHW and MLW: In Scotland, Ordnance Survey (OS) maps consistently shows high and low water marks for ordinary spring tides, which "generally occur the third of fourth tide after new or full moon" as the main tidelines; • The line reflecting the alignment of the mean spring high tide is attributed with a Function of 'Mean High Water Spring Mark' (MHWSM). • The line reflecting the alignment of the average mean spring low tide is attributed with a Function of 'Mean Low Water Spring Mark' (MLWSM). • If the alignments are coincident then the line is attributed with a function of 'Mean High Water Spring Mark and Mean Low Water Spring Mark'. In England and Wales, the tide lines mapped on the OS County Series maps has changed over time: • Since 1879 are Low Water Mark of Ordinary Tides (LWMOT) and High Water Mark of Ordinary Tides (HWMOT) which are "those of high and low water of ordinary tides (i.e. tides half way between neaps and springs) which define the limit of the foreshore". • The OS's 1905 instructions to field examiners contained similar advice: surveys of Mean High Water (MHW) and Mean Low Water (MLW) were taken from "tides half way between a spring and a neap, and should generally be taken at the fourth tide before new and full moon". The name changes from MHWOT to MHW and MLWOT to MLW are not significant as the definitions remained the same. Note, however, that MHW and MLW are not given in Admiralty Tide Tables, which is not a problem provided consistent calculations of MHW and MLW are performed. • Since about the 1970s the OS has mainly provided tide line data from aerial surveys preferably using black & white infrared film as this shows the water/foreshore interface more clearly. Admiralty tide tables were examined to find high and low tides which were within ± 0.3metres of MHW and MLW.

	In Northern Ireland, coast wide erosion mapping and extrapolation studies have not been undertaken as in the rest of UK. Historical maps (1832-1963) exists for but does not cover the entire shoreline and the level of detail included in the maps also varies, with some including high and low water contours and elevation contours [2]. [1] Sutherland, James. "Error analysis of Ordnance Survey map tidelines." Maritime Engineering (2012). [2] DAERA & DFi, (2018). "Baseline Study and Gap Analysis of Coastal Erosion Risk Management NI" www.infrastructure-ni.gov.uk/
Uses and benefits:	County Maps are the only widespread source of information which can be used to quantify trends in coastal evolution over periods greater than about 70 years in the UK. Tidelines is of legal interest and also used as an indicator of standard of protection. This product allows management authorities of flood and coastal erosion risk to create a coastal erosion baseline from which other decisions can be made and priorities flow. Will allow coastal engineering practitioner and research community to better understand process of change and validate conceptual and numerical models used to assess coastal change and adaptation options.
Product Specifications	
Spatial scale:	1:2,500 in rural areas, 1:1,250 in urban areas and 1:10,000 in upland areas (Scales chosen to be consistent with the standard scales used by OS mapping as described by Olivier 2005) Oliver R (2005) Ordnance Survey maps: a concise guide for historians (2nd edition). The Charles Close Society, London, UK.
Minimum cell size: (or mapping unit)	To be consistent with OS MasterMap revision policy on the Coastal zone the minimum change mapped due to natural erosion and deposition in the coastal zone is the one resulting in a change of alignment of more than 10 m over a length of more than 100 m for the following coastal features when well defined; Top and bottom of cliffs; and Coastal slope limits.
Information layers:	Spatial Reference System (EPSG 277000 British National Grid) Tidelines; vector lines for different tide elevations (LWMOT, HWMOT, MLWSM, MHWSM) Error lines; Lines that have errors (for instance not closed rings or self-intersections) Date and time; of the image used to delineate the tideline Uncertainty in the elevation of the tide level Uncertainty in the elevation due to waves and atmospheric processes Uncertainty in the horizontal location of the tideline associated to uncertainty on vertical elevations

Product format:	Vector format; GML (Geography Markup Language) ESRI Shapefile
Software platform compatibility:	The products should be compatible with the following commercial and open source GIS: ArcGIS & ArcMap 10.3.1, Quantum GIS 2.18
Product accuracy:	To be consistent with OS accuracy definitions we define accuracy in three different ways: **Absolute accuracy** – how closely the coordinates of a point in the dataset agree with the coordinates of the same point on the ground (in the British National Grid reference system). **Relative accuracy** – positional consistency of a data point or feature in relation to other local data points or features within the same or another reference dataset. **Geometric fidelity** – the 'trueness' of features to the shapes and alignments of the objects they represent -when testing the data according to the dataset specification against the 'real world' or reference dataset. The following table represents the absolute and relative accuracy applicable to the scale at which the product was surveyed.

Survey scale	**RMSE***
1:1,250	
Absolute Accuracy	0.5 m
Relative Accuracy	+/- 0.5 m (up to 60 m)
1:2,500	
Absolute Accuracy	1.1 m
Relative Accuracy	+/- 1.0 (up to 100 m)
1:10,000	
Absolute Accuracy	4.1 m
Relative Accuracy	+/- 4.0 m (up to 500 m)

*RMSE (root mean squared error) is the square root of the mean of the squares of the errors between the observations.

Service Specifications	
Years of interest:	Interested in years since 1970s until present

Temporal range:	Not applicable
Updating frequency:	It varies accordingly with OS MasterMap revision policy. https://www.ordnancesurvey.co.uk/about/governance/policies/os-mastermap-revision.html Today, major coastal and non-coastal defences designed to reduce the risk of flooding are in the OS Category A, which means they will be captured as part of a continuous revision process within six months of completion. Mean high and low water when affected by changes to other features (such as coastal defences or jetties) and significant changes to tidelines (when evident from aerial photography conducted as part of the national sweep or when notified by a customer) are classified as Category B and will be captured as part of a national sweep programme, which occurs every few years [1].
Temporal baseline:	1948* based on Defra interest on assessing property lost since data is available. *The baseline year correspond with the first Royal Air Force (RAF) aerial imagery.
Ordering:	Web based ordering system
Delivery time required:	Within 6 months of ordering
Delivery format:	Web-based (http), ftp
Validation data	
Available at the end-user's premises:	As a Public Sector Organization, BGS has access to; OS historic maps and MasterMap up to 2015 for the whole UK under OS/PSMA terms and conditions. Vertical Offshore Reference Frames (VORF) to provide the vertical correction from Chart Datum to Newlyn Ordnance Datum (reference datum used in UK for tides) for any location around UK and UKCS.
Available elsewhere:	Storm surge levels reports can be downloaded from: https://www.ntslf.org/storm-surges/monthly-surge-plots Registered tide levels can be downloaded from: https://www.bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/processed_customise_time_selection/ Admiralty Tide Tables are available from http://www.ukho.gov.uk/easytide/EasyTide/SelectPort.aspx Aerial Photography (oblique and orthophotography) are collected regularly and made publically available by DAERA, EA, SEPA

	Beach profiles for England can be downlowaded from www.channelcoast.org Continuous measurements of wave energy fluxes (i.e. height, direction and wave period) for the entire UK can be downloaded from http://wavenet.cefas.co.uk/Map
Planned collection and when:	For planned OS MasterMap collection and publication see https://www.ordnancesurvey.co.uk/business-and-government/help-and-support/products/os-mastermap-refresh-dates.html For planned data collection of other auxiliary data indicated above, visit the indicated links.

Table 7. Product description BGS #2: Datum-based Tidelines

Description of product no. 2	
General Description	**A tideline obtained by extracting a contour at different tidal elevations**
General service/product description:	An increasing volume of beach level data (i.e. beach profiles, LiDAR surveys and RADAR flights) is being regularly and systematically collected along UK coastline, from which the positions of contours representing MHW, MLW and other datum elevations can be obtained. Proxy-based and datum-based shorelines might differ [1]. A series of shoreline repeatability and variability experiments as well as data from a beach monitoring program along the high-energy US Pacific Northwest coast, indicate total uncertainty estimates of the horizontal position of proxy-based shorelines to be approximately ± 50-150 m for T-sheets and aerial photography and approximately ± 15 m for datum-based shorelines derived from ground- or air-based topographic surveys. The differences between the two do not appear to have been analyzed in the UK [2]. Datum-based tideline are therefore obtained from a Digital Elevation Model (DEM) of the coastal zone (backshore and foreshore) and an automatic contour extraction method. As end user we are interested on both, the datum-based contour and DEM derived from satellite imagery. [1] Ruggiero P, Kaminsky GM and Gelfenbaum G (2003) Linking proxy-based and datum-based shorelines on a High-Energy coastline: Implications for shoreline analyses. Journal of Coastal Research Special Issue 38: 57-82. [2] Sutherland, James. "Error analysis of Ordnance Survey map tidelines." Maritime Engineering (2012).
Uses and benefits:	Tidelines is of legal interest and also used as an indicator of standard of protection.

	This product allows management authorities of flood and coastal erosion risk to create a coastal erosion baseline from which other decisions can be made and priorities flow. Will allow coastal engineering practitioner and research community to better understand process of change and validate conceptual and numerical models used to assess coastal change and adaptation options.
Product Specifications	
Spatial scale:	1:2,500 in rural areas, 1:1,250 in urban areas and 1:10,000 in upland areas (scales chosen to be consistent with the standard scales used by OS mapping)
Minimum cell size: (or mapping unit)	To be consistent with the methodology used recently in Scotland to assess the historical rates of coastal change [3] a minimum cell size of 10 m is desirable. [3] Fitton, J. M., J. D. Hansom, and A. F. Rennie. "Dynamic Coast-National Coastal Change Assessment: Methodology." (2017).
Information layers:	Spatial Reference System (EPSG 277000 British National Grid) Tidelines; vector lines for different tide elevations (LWMOT, HWMOT, MLWSM, MHWSM) Digital Elevation Model; used to extract the different tide contours Error lines; Lines that have errors (for instance not closed rings or self-intersections) Date and time; of the image used to delineate the tideline Uncertainty in the elevation of the tide level Uncertainty in the elevation due to waves and atmospheric processes Uncertainty in the elevation of the DEM Uncertainty in the horizontal location of the tideline associated to uncertainty on vertical elevations
Product format:	Vector and Raster formats; Vector for the tidelines: GML (Geography Markup Language), ESRI Shapefile Raster for the DEM: ASCII, TIFF & GeoTIFF uncompressed and compressed (LZW, ZIP)
Software platform compatibility:	The products should be compatible with the following commercial and open source GIS: ArcGIS & ArcMap 10.3.1, Quantum GIS 2.18

Product accuracy:	Same accuracy requirements as for proxy-based tidelines and to be consistent with OS accuracy definitions (see definitions and accuracy on proxy-based tidelines product description).
Service Specifications	
Years of interest:	Interested in years since 1970s until present
Temporal range:	Not applicable
Updating frequency:	Same updating frequency requirements as for proxy-based tidelines and to be consistent with OS accuracy definitions (see explanation on proxy-based tidelines product description). Frequency might varies from six months since change observed or work completion to few years.
Temporal baseline:	1948 (or as close as possible)
Ordering:	Web based ordering system
Delivery time required:	Within 6 months of ordering
Delivery format:	Web-based (http), ftp
Validation data	
Available at the end-user's premises:	In addition to the data described on Proxy-based tideline product description, BGS as a Public Sector Organization, BGS has access to; NEXTMap® Britain provides users with highly accurate Digital Elevation Models which model the ground surface in great detail [Intermap Technolgies, 2009]. Produced by Intermap, was derived from airborne Interferometric Synthetic Aperture Radar (IFSAR). The dataset covers all of England, Wales and Scotland ✓ An elevation point provided every five metres and a vertical accuracy of one metre ✓ Selected more densely populated areas are available with a vertical accuracy of 50 centimetres ✓ A digital orthorectified radar image (ORI) data set is also available providing a highly detailed grey scale image of the earth's surface ✓ Available as a DSM, DTM and Contours at 5m or 10m postings Intermap Technologies (2009): NEXTMap British Digital Terrain (DTM) Model Data by Intermap. NERC Earth Observation Data Centre, date of citation. http://catalogue.ceda.ac.uk/uuid/998a28d8a5ed4564863a0daa0f731e8d

Available elsewhere:	In addition to the data described on Proxy-based tideline product description: LiDAR data (raw data and DTM and DSM at 1 m, 50 cm raster cell) along England, Wales, Scotland and Northern Ireland coastal zone are available from; EA for England and Wales and Scottish Natural Heritage (SNH) for Scotland and DAERA and OpenDataNI for Northern Ireland.
Planned collection and when:	For planned OS MasterMap collection and publication see https://www.ordnancesurvey.co.uk/business-and-government/help-and-support/products/os-mastermap-refresh-dates.html For planned data collection of other auxiliary data indicated above, visit the indicated links and Agencies web sites.

Table 8. Product description BGS #3: Seamless Topo-Bathy metric Digital Elevation Models

Description of product no. 3	
General Description	**Seamless (i.e. no data gaps between topography and bathymetry) Topography and Bathymetry Digital Elevation Model of the coastal zone (backshore, foreshore & nearshore)**
General service/product description:	Any policy for coastal erosion should increase coastal resilience by restoring the sediment balance and providing space for coastal processes (EUROSION, 2004). In this context, coastal managers have shifted their interest from coastline management (1D) to volume and space management (3D) over time (4D). This has created a demand on the surveyors to create seamless TPDEM of the coastal zone to allow them assess close sediment balance. This product is a raster product containing a time stamped Digital Elevation Model of the coastal zone (including backshore, foreshore and nearshore). This product will be delivered as both a Digital Surface Model (DSM) and Digital Terrain Model (DTM).
Uses and benefits:	Assess geomorphic change and volumes of sediment eroded and deposited by subtraction of two independent DTM surfaces to produce a DTM of Difference (DoD), with each grid cell value representing a measure of the vertical elevation difference. Extract information of a number of Coastal State Indicators used for coastal management [1]:

CSI*	Quantity represented	Spatial separation	Time between measurements	Case Study
Dune strength	SoP for storm	250 m	5 years	Dutch coast
Barrier width	SoP for storm	180 m	1 month	Pevensey, UK
Total barrier volume	SoP for storm	180 m	1 month	Pevensey, UK
Backshore width	SoP for storm	Mean 1.75 km	1 year	Black Sea
Dune zone width	SoP for storm	Mean 1.75 km	1 year	Black Sea
Dune zone height	SoP for storm	Mean 1.75 km	1 year	Black Sea
Momentary coastline	Position & boundary condition for SoP	250 m	1 year	Dutch coast
Beach width	Boundary condition for SoP of hard defence	100 m	6 months	Costa Brava, Spain
Barrier crest position	Position	180 m	1 month	Pevensey, UK
Shoreline position	Position	Few m	4 to 5 years	Black Sea
Shoreline position	Position	≤ 500 m	1 year	Hel peninsula, Poland
Coastline position	Perception of safety	Irregular	Event-driven	Inch Strand, Ireland
Coastal foundation	Rise with sea level	250m	Several years	Dutch coast
Shoreface volume	Flood and coastal erosion risk	500m	4 years	Hel peninsula, Poland
Coastal slope	Flood and coastal erosion risk	Mean 1.75km	4 to 5 years	Black Sea

SoP: standard of protection

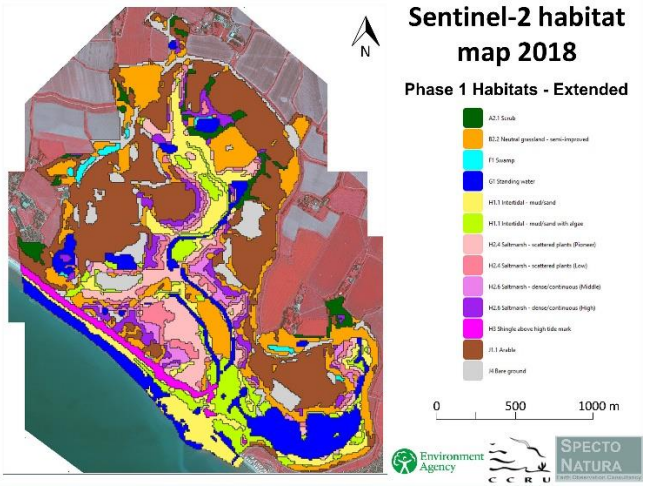
[1] Payo et al., 2018. Geomorphic State Indicators for coastal management over decades and longer time scales. DOI: 10.13140/RG.2.2.27099.05923

Product Specifications	
Spatial scale:	Not applicable
Minimum cell size: (or mapping unit)	A minimum cell size of 5 m is desirable.
Information layers:	Timestamp; date of data collection of images used to create TBDEM Spatial Reference System (preferred EPSG 277000 British National Grid) Datum (preferred for Great Britain is Ordnance Datum Newlyn and Belfast Ordnance Datum for Northern Ireland) Digital Surface Model; raster surface elevation model Digital Terrain Model; raster relief elevation (i.e. excluding structures and vegetation) Uncertainty in the elevation of DSM Uncertainty in the elevation of DTM
Product format:	Raster: ASCII, TIFF & GeoTIFF uncompressed and compressed (LZW, ZIP)

Software platform compatibility:	The products should be compatible with the following commercial and open source GIS: ArcGIS & ArcMap 10.3.1, Quantum GIS 2.18
Product accuracy:	+/-15cm RMSE (to allow comparison with with EA LiDAR data)
Service Specifications	
Years of interest:	Interested in years since 1970s until present
Temporal range:	Not applicable
Updating frequency:	Frequency might varies from one month to five years (see table on Uses description).
Temporal baseline:	1948 (or as close as possible)
Ordering:	Web based ordering system
Delivery time required:	Varies with updating frequency from 15 days for 1 indicators that have a 1 month updating frequency to 6 months for those with few years updating frequency.
Delivery format:	Web-based (http), ftp
Validation data	
Available at the end-user's premises:	Same as data described for Proxy-based tideline and datum-based tideline products description.
Available elsewhere:	In addition to the data described on Proxy-based tideline & Datum-based tideline products description: Bathymetries for the whole UKCS from the Admiralty Data Portal web site which includes Bathymetric surveys from various sources including over 4,000 bathymetry surfaces from 1970 to present day. The bathymetry data is updated every three months and a large number have been funded by the MCA, an executive agency sponsored by the Department for Transport, under the Civil Hydrography Programme. (https://data.admiralty.co.uk/portal/apps/sites/#/marine-data-portal)
Planned collection and when:	For planned OS MasterMap collection and publication see https://www.ordnancesurvey.co.uk/business-and-government/help-and-support/products/os-mastermap-refresh-dates.html

	For planned data collection of other auxiliary data indicated above, visit the indicated links and Agencies web sites.

Table 9. Product description BGS #4: Habitat map

Description of product no. 3	
General Description	**Habitat map**
General service/product description:	This product is a vector polygon product containing a time stamped Habitat map of the coastal zone (including backshore, foreshore and nearshore). The size of the backshore area is defined by the end users preferred height values corresponding to tidal limits. The minimum level of classes to be identified are the Sentinel-2 based habitat map [1]. An enlarged copy of the figure below showing the different classes can be found here https://sentinel.esa.int/documents/247904/3833380/Sentinel-2-Medmerry-habitat-map-full.jpg). This habitat map is a remotely sensed product which classify site relevant habitats visible at the time of satellite capture. The classification uses supervised classification techniques; these are techniques which are trained using ground data. The EA habitat descriptions for CASI and LIDAR habitat maps are proposed to be used [1] but we are aware that some modification might be needed [2] (Figure below).  [1]EA CASI and LIDAR Habitat Map. https://data.gov.uk/dataset/1707e638-6a2d-48f5-a534-1db0b240cc37/casi-and-lidar-habitat-map [2]https://sentinel.esa.int/web/sentinel/home/-/journal_content/56/247904/3834405

Uses and benefits:	Habitat creation achieved as part of coastal managed realignment schemes has been estimated to provide environmental benefits valued at between £680 and £2,500 per hectare, including carbon storage benefits. Furthermore, the Climate Change Committee (2013)1 advised that 6200 ha of coastal habitat created nationally by 2030 (costing £10-15M per annum) would save £180-£380M in capital and maintenance costs on coastal flood and erosion management over the long-term when compared to the cost of replacing/maintaining hard defences. The successful implementation of such schemes, however, requires trustworthy data and information from existing schemes and that, in turn, requires replicable, cost-efficient, and fit-for purpose monitoring programmes of both existing and planned future schemes.
Product Specifications	
Spatial scale:	Not applicable
Minimum cell size: (or mapping unit)	For a class to be mapped on site there must have been samples collected for it on site.
Information layers:	Timestamp; date of data collection Spatial Reference System (preferred EPSG 277000 British National Grid) Vector polygon with the different habitats. Habitats types described in [1]
Product format:	Vector polygon GML (Geography Markup Language), ESRI Shapefile
Software platform compatibility:	The products should be compatible with the following commercial and open source GIS: ArcGIS & ArcMap 10.3.1, Quantum GIS 2.18
Product accuracy:	Quantitative accuracy assessment carried out on them in the form of a confusion matrix using ground data set aside and not used in training the classifier
Service Specifications	
Years of interest:	Interested in years since 1970s until present
Temporal range:	Not applicable

Updating frequency:	Frequency might varies from one month to a year.
Temporal baseline:	1948 (or as close as possible)
Ordering:	Web based ordering system
Delivery time required:	Varies with updating frequency from 15 days for 1 indicators that have a 1 month updating frequency to 6 months for those with one year updating frequency.
Delivery format:	Web-based (http), ftp
Validation data	
Available at the end-user's premises:	Same as data described for Proxy-based tideline, Datum-based tideline, TBDEM products descriptions.
Available elsewhere:	In addition to the data described on Proxy-based tideline, Datum-based tideline and TBDEM products description: CASI and LIDAR Habitat Map from EA. A habitat map derived from airborne data, specifically CASI (Compact Airborne Spectrographic Imager) and LIDAR (Light Detection and Ranging) data. The habitat map is a polygon shapefile showing site relevant habitat classes. Geographical coverage is incomplete because of limits in data available. It includes those areas where the Environment Agency, Natural England and the Regional Coastal Monitoring Programme have carried out sufficient aerial and ground surveys in England. Habitat maps generated by Geomatics are often derived using multiple data sources (e.g. CASI, LIDAR and OS-base mapping data), which may or may not have been captured coincidentally. In instances where datasets are not coincidentally captured there may be some errors brought about by seasonal, developmental or anthropological change in the habitat. URL: https://data.gov.uk/dataset/1707e638-6a2d-48f5-a534-1db0b240cc37/casi-and-lidar-habitat-map
Planned collection and when:	For planned OS MasterMap collection and publication see https://www.ordnancesurvey.co.uk/business-and-government/help-and-support/products/os-mastermap-refresh-dates.html For planned data collection of other auxiliary data indicated above, visit the indicated links and Agencies web sites.

GEOLOGICAL SURVEY IRELAND (GSI)

Table 10. End-User Organization: GSI

1. End-User Organization	
Name:	Geological Survey of Ireland (GSI)
Type of organization:	Governmental organization
Description:	The geological Survey of Ireland is the national earth science knowledge centre, working on behalf of the Irish public. We are committed to providing accurate data and maps on Ireland's subsurface to landowners, the public, industry, and all other stakeholders.
Department/Division/Section/ Unit	Marine and Coastal unit and land mapping programme
Website	www.gsi.ie
Contact person	Koen Verbruggen, Director GSI Beggars Bush, Haddington Road D04 K7X4, Dublin, Ireland Tel: 0035316782864 email: koen.verbruggen@gsi.ie Xavier Monteys, Senior Geologist Beggars Bush, Haddington Road D04 K7X4, Dublin, Ireland Tel: 0035316782807

Table 11. Requirements Overview: GSI

2. Requirements Overview	
Description of the requested service:	The Geological Survey Ireland is committed to providing free, open and accurate data and maps on onshore and offshore Ireland's subsurface to landowners, the public, industry, and all other stakeholders. The proposed services can be categorized in 1. Development of indexes and parameters for the assessment of coastal erosion, at distance and time scales required, with the aim to be integrated within the Coastal Vulnerability Index (CVI) to sea level rise 2. Produce a coastal land cover classification to guide the coastal erosion assessment 3. Assessment of the coastal erosion impacts at the shoreline level 4. Assessment of sediment volume change from backshore to foreshore attributed to coastal erosion (20 years analysis)

	5. Derive high resolution coastal Digital Elevation Models (DEM) from EO data 6. Develop a near shore bathymorphology to assess changes due to sediment transport and erosion 7. Assess the coastal erosion vulnerability to storm surge events in selected coastal regions
Current Practices:	1. Coastal flooding: the Office of Public Works (OPW) has developed the Irish Coastal Protection Strategy Study (ICPSS), a national study that was commissioned in 2003 with the objective of providing information to support decision making about how best to manage risks associated with coastal flooding and coastal erosion. The Study was completed in 2013 and provides strategic current scenario and future scenario (up to 2100) coastal flood hazard maps and strategic coastal erosion maps for the national coastline. This major study provides invaluable and essential information required to inform policy in this area, particularly for local authorities in relation to the proper planning and development of coastal areas. Information can be accessed here: https://www.opw.ie/en/flood-risk-management/floodanderosionmapping/icpss/ 2 Coastal Vulnerability Index mapping to evaluate impacts of sea-level rise. Geological Survey Ireland is undertaking a new mapping initiative in the climate adaptation strategy. The first phase of CVI mapping (2019-2020) will map areas from north Co. Louth to Co. Wexford. More information here: https://www.gsi.ie/en-ie/programmes-and-projects/marine-and-coastal-unit/projects/Pages/Coastal-Vulnerability-Index.aspx 3. The INFOMAR program (ww.infomar.ie), led by GSI and the Irish Marine Institute, acquires near shore bathymetry following international hydrographic standards. Generally this type of data is acquired using ship borne acoustic methods or marine Lidar. A nuber of Volumetric change studies have been carried out in selected coastal areas where airborne topographic Lidar data were available for several years
Motivation and expectation:	Coastal monitoring using EO satellite tools will allow up to date map information on Coastal Vulnerability to a range of environmental issues, including coastal erosion and sea level rise. 1. Geological Survey Ireland is currently developing a Coastal Vulnerability Index mapping to sea level rise. Key parameters currently used in the CVI can potentially be derived from satellite data 2. Satellite data can be used to monitoring change I shallow submerged areas. GSI aims to provide a baseline water depth information in the “White ribbon” for a variety of mapping outputs and coastal oceanographic models. To provide information methods and validity to monitor near shore sediment change using Earth Observation data 3. Satellite monitoring can be used to assess quantitatively volumetric change in coastal areas and beaches, thus enhancing our knowledge in coastal processes. 4. Coastal land classification using available satellite data can be used a as a baseline information layer for a number of coastal products

Table 12. Area of Interest: GSI

3. Area of Interest

Name:	Irish Coastal Zone
Type:	Coastal and estuarine Areas
Geographical coordinates and size of area of interest:	Latitude: 55.5N; 51.3N Longitude: -5.87 W - -10.5 W Size (km^2): Length (km): 3171 (OSI)
Geographical coordinates and size of service demonstration area:	Area #1 Name: East Coast (Irish Sea) Latitude: 54.1N; 52.17N Longitude: -10.24 ;-9.66 Size (km2): Length (km): 450 Site #1Dublin bay: (53.282,53.390; -5.961,-6.266)- 30 km length Site #2 Portrane-Donabate: (53.400,53.545; -6.009,-6.181)- 25 km L Site #3 Greystones- Wicklow (52.971,53.167; -6.015,-6.092)- 24 km Site #4 Blackwater- Rosslare Harbour (52.231,52.56; -6.165,-6.515)- 50 km Area #2 Name: South coast (Celtic Sea) Latitude: 52.43N; 51.97N Longitude: -10.24 ;-9.66 Size (km^2): 600 Length (km): 150 Site #5 Waterford estuary (52.111,52.389; -6.711,-7.192)- 74 km Site #6 Cork Harbour (51.736,51.915; -8.135,-8.439)- 27 km Area #3 Name: SW Bays Latitude: 53.31N; 53.03N Longitude: -9.84 ;-8.86 Size (km^2): 1900 Length (km): 120 Site# 7-Smerwick Harbour (52.166,52.237; -10.334,-10.432)- 15 km Site #8; Tralee to Brandon Bay (52.222,52.334; -9.731,-10.21)- 57 km Area 4 #3

	Name: West Coast Latitude: 51.97N; 51.72N Longitude: -8.52 ;-8.016 Size (km^2): 900 Length (km): 110 Site# 9 Achill- Dooagh beach (53.947,53.977; -10.094,-10.190)- 7 km Site #10 Ballyness Bay (55.120,55.234; -7.98,-8.211)- 23 km
Description:	Operational area of interest Area 1 The area of interest is a long varied coastline along the Irish Sea coast of approximately 450 km. It is characterized by bays separated by low rock heads. The bays are cut into glacial drift deposits. Features include sand spits, dunes, single and sand bars and intertidal flats. Several estuaries are present in the area. Site #1 Dublin Bay Dublin Bay is a large sandy bay in a urban area bisected by the estuary of the River Liffey.The bay is about 10 kilometres wide along its north-south base, and 7 km in length to its apex at the centre of the city of Dublin. Dublin Bay is a large sandy bay, enclosed within seawalls. The estuary of the River Liffey is now largely retained within quays and sea-walls. There are also beaches of shingle north and south of Dublin. There are rocky cliffs at Howth and Dun Laoghaire. Dublin is the largest city in Ireland with approximately 1M people. Site #2 Portrane- Portmarnock beachThe Donabate peninsula forms a distinctive shape characterized by the mouths of two estuaries surrounding the peninsula partially closed large sand spits stretching north to south. The northern spit contains Portrane beach which almost touches Rush South Beach but for a narrow channel entering the Rogerstown esutary. A stretch of low limestone cliffs to the south of Portrane beach leads to Donabate Beach which is the east face of the southern spit. The southern Broadmeadow estuary is likewise almost completely enclosed and is fed by the broadmeadow river. The shelter provided by the spits had made the estuaries important wildlife habitats and both are protected under the international Ramsar Convention.Site #3 Greystones- wicklow Greystones beach is a mix of pebble and sand and is located at the southern end of the town of Greystones. South of here the coast is characterised by a long straight shingle beach, stretching as far as Wicklow Town, inland of which occurs the largest Wetland complex on the East coast of Ireland. Site #4 Blackwater- Rosslare The study area is located in long sandy beach starting in Blackwater and ending in a low head with sand bars and tidal bars in the mouth of the river Slaney, a wide and shallow estuary (Rosslare Harbour)The area suffers from coastal erosion and flooding.

	Area 2 Site 5:Waterford estuary The Three Sister Rivers enter the sea at Waterford Harbour. The estuary of the Three Sister Rivers provides a large natural habitat for wildlife, and includes areas of intertidal mudflats, low cliffs, marsh and a large reedbed Site 6: Cork harbor It is a natural harbour and river estuary at the mouth of the River Lee in County Cork, Ireland. It is a very large natural harbour located close to the city. It is a large, sheltered harbour with many river estuaries including the Rivers Owenacurra, Douglas and Lee. The extensive mudflats and salt marshes around Lough Mahon and the Douglas Estuary shelter wildlife habitats that are of national importance, as well as associated flora and fauna. Area 3 Site 7: Smerwick harbour Smerwick Harbour is situated on the west coast of Ireland in Co. Kerry. It a small closed embayment characterized by sandy beaches separated by rock heads Site 8: Tralee and Bandon Bay Tralee Bay and Magharees Peninsul is a large site that stretches from Tralee town westwards to Fenit Harbour and Cloghane, encompassing Tralee Bay, Brandon Bay and the Magharees Peninsula. It includes extensive mudflats at the eastern end, the beaches of Derrymore Island, the sand dunes and lagoons of the Magharees Peninsula, as well as the rocky headlands at its end. The site is mostly underlain by limestone with significant parts covered with glacial drift or windblown sand. The main exposures occur at Fenit port, Oyster Hall, Blennerville and Rough Point and Fahamore, as well as some low outcrops on the beaches west to Castlegregory. Elsewhere the sandstones and slates of the Dingle Beds appear. Area 4 Site 09 Achill- Dooagh beach Dooagh, on Achill Island. Small beach a(a few hundred meters). Site 10:Falcarragh, Donegal Drumnatinny Beach is located on the North West coast of Donegal approx 3km north of Falcarragh Town. This coast stretch has the Special Area of Conservation.
Problems/issues:	Operational area of interest Coastal flooding and erosion Site #1 Impact of dredging within Dublin Port is a major issue for this site. Environmental concerns and water quality Decadal Sea level monitoring Site #2

	Coastal erosion and near shore sediment transport are key issues affecting this zone. Rapid coastal erosion linked to storm events Higher water levels than expected (frequently more than 1m higher than the predicted astronomical tide, and up to 1.5m higher than predicted). Site #3 Coastal erosion and environmental concerns including habitats. High CVI Site #4 Coastal erosion and infrastructures Site #5 monitoring estuary dynamics Site #6 monitoring estuary dynamics Site #7 monitoring coastal erosion, sea level and submerged landscapes Site #8 monitoring coastal erosion, sea level and submerged landscapes Site #9 monitoring coastal erosion Site #10 monitoring coastal erosion
User organizations:	at all sites: • The Geological Survey Ireland; • The Office of Public Works in Ireland is responsible for coastal flooding and coastal erosion in Ireland; • Local authorities / County councils are responsible for planning and managing their respective coastline; • CARO:.Local Authority Climate Action Regional Offices (CAROs) have been established to drive climate action at regional and local level in Ireland. • EPA (Environmental protection Agency) is responsible for coastal environmental protection and climate action • OSI is responsible for mapping the Irish coastline (MHWS) • Department of Housing, Planning and Local Government: implements the National Marine Planning Framework & Marine Spatial Planning (MSP) • Irish Marine Institute provide scientific and technical advice to the government to inform policy and support the sustainable development of Ireland's marine resources.

Available data:	at all sites: 1. National scale airborne radar DTM data 10 x10m 2. Aerial photography: several surveys covering the entire coastline. Years: 1952;1970,,1996, 2000;2005, 2012 3. Lidar DEM/DSM data: a. OSI:2012 b. OPW:2007 c.Irish Railway Lidar topographic lidar 2011 (sites #3,#4) 4. GSI INFOMAR Bathymetry data covering ca. 75% of near shore study area 5. GSI Geological maps @ 1:50,000 6. AUV photogrammetry data for selected sites (GSI) 7. Laser scanner topographic data for selected sites (GSI)

Table 13. Product description GSI #1: Monitoring bathymetric change in the nearshore

Description of product no. 1	
General Description: Monitoring bathymetric changes in all sites (Sites #1 ,#2,#3,#4,#5,#6,#7,#8,#9#10)	
General service/product description:	Satellite Derived Bathymetry and morphology in the nearshore - Site #1 to #10 : Monitoring bathymetrychange over time up to 10m water depth using optical and radar datasets
Uses and benefits:	GSI will use this product to assess the validity to monitor change from EO data: Site #1: monitoring dredging activity and environmental awareness Site #2 monitoring an active coastal erosion in a urban area Sites #3 #4 monitoring coastal erosion and coastal dynamics Sites #5 #6 monitoring estuary dynamics Sites #7 #8 monitoring coastal erosion, sea level and submerged landscapes Sites #9 #10 monitoring coastal erosion
Product Specifications	
Spatial scale:	1:5,000
Minimum cell size: (or mapping unit)	Sentinel 1 & 2: 10m Rapid Eye: 5 x 5m VHR MS satellite : 1 x 1m

Information layers:	Bathymetry maps for all sites and year. Spatial reference system: EPSG:2157 IRENET95 / Irish Transverse Mercator Bathymetry Model Uncertainty in the water depth of the bathymetry model Uncertainty in the positioning of the bathymetry Information on Z data points density (per pixel)
Product format:	o GIS Vector datasets (XYZ) o GIS Raster datasets (i.e: depth)
Software platform compatibility:	Compatible with ARCGIS 10.3 and QGIS
Product accuracy:	Relative Accuracies *1.Sentinel 1 & 2: 1 m vertical and 10 m horizontal* *2. VHR MS: 1 m vertical and 1 m horizontal*
Service Specifications	
Years of interest:	N/A
Temporal range:	Site 1 1990-2020 Site 2 2007-2020 Site 3 2007-2020 Site 4 2007-2020 Site 5 2007-2020 Site 6 2007-2020 Site 7 2007-2020 Site 8 2007-2020 Site 9 2016-2020 Site 10 2007-2020
Updating frequency:	Twice a year
Temporal baseline:	1990

Ordering:	Web based ordering system.
Delivery time required:	6 months
Delivery format:	.Web-based
Validation data	
Available at the end-user's premises:	Bathymetric surveys carried out by INFOMAR (GSI and MI) between 2003 and 2019 Admiralty Navigation charts
Available elsewhere:	o digital, orthorectified aerial photos from 1998 covering half of the area of interest; o Continuous measurements of wave height from five buoys in the area (MI and IL) o Lidar topographic data (only intertidal): OPW and OSI
Planned collection and when:	GSI will acquire bathymetric surveys in 2019 and 2020 in selected sites (TBD) GSI has plans to acquire AUV in intertidal areas– photogrammetric data for selected sites

Table 14. Product description GSI#2: Coastal DEM derived from EO

Description of product no. 2	
General Description	**Coastal DEM derived from EO for Sites #1 ,#2,#3,#4,#5,#6**
General service/product description:	Production of a DEM model from the backshore to the foreshore (MLWM) using EO data
Uses and benefits:	GSI will use this product to assess the accuracy of satellite derived DEM in relatively flat coastal areas Time series of DTM can be used to monitor coastal change
Product Specifications	
Spatial scale:	1:5.000
Minimum cell size: (or mapping unit)	Sentinel 1 & 2: 10m Rapid Eye: 5 x 5m

	VHR MS satellite : 1 x 1m
Information layers:	Topographic layers with elevation information Spatial reference system: EPSG:2157 IRENET95 / Irish Transverse Mercator Digital Elevation Model Uncertainty in the elevation of the DEM Uncertainty in the positioning of the DEM Information on Z data points density (per pixel)
Product format:	Vector data XYZ GIS shapefile
Software platform compatibility:	Products should be compatible with ArcGIS 10.3 or QGIS
Product accuracy:	1. Sentinel 1 & 2: 25 cm vertical and 5 m horizontal 2. VHR MS: 25 cm vertical and 1 m horizontal
Service Specifications	
Years of interest:	Not applicable.
Temporal range:	Years 2007, 2012 and 2020.
Updating frequency:	Once a year
Temporal baseline:	1990
Ordering:	Web based ordering system.
Delivery time required:	6 months
Delivery format:	Web-based.
Validation data	

Available at the end-user's premises:	Lidar topographic data 2007, 2011, 2012 AUV photogrammetric data 2018 for selected sites
Available elsewhere:	Airborne interferometry DTM 5 x 5 m . National coverage (OPW) Digital Globe VHR satellite data Blue Sky airborne topo lidar and orthophotos: https://www.bluesky-world.ie/
Planned collection and when:	AUV photogrammetric data 2019 -2020

Table 15. Product description GSI#3: Waterlines

Description of product no. 3	
General DescriptionExtraxtion of multiple image-based waterlines and convert them to tidelines (Sites #1 ,#2,#3,#4,#5,#6,#7,#8,#9#10)	
General service/product description:	Automatic shoreline change monitoring using EO archival data: Automatic waterline extractions in the coastal stretch from EO optical and radar imagery. Assign tidal information to the waterlines. Add additional relevant meteorological information. Include data and methodological uncertainties. **(Sites #1 ,#2,#3,#4,#5,#6,#7,#8,#9#10)**
Uses and benefits:	Tidelines are of legal interest and also used as an indicator of standard of protection. Tidelines are relevant in managing coastal flooding and coastal erosion at local and national scale GSI will use the shoreline information to compare with existing legal HWM and LWM from other data sources (i.e. OPW and OSI). In selected areas (e.g. Site#1) decadal monitoring can be investigated and used to validate sea level local models
Product Specifications	
Spatial scale:	1:1,000 (urban areas) 1:2,000 (non-urban areas)
Minimum cell size: (or mapping unit)	10m (sentinel-2) 5m Rapid Eye datasets 1 m (when VHR satellite data are available)

Information layers:	Spatial reference system: EPSG:2157 IRENET95 / Irish Transverse Mercator Tidelines: Vector lines representing tidally corrected vertical positions: : MHWSM, MLWSM Date and time of the image used to delineate the tideline Uncertainty in the elevation of the tide level Uncertainty in the elevation due to waves and atmospheric processes Uncertainty in the horizontal location of the tideline
Product format:	o Vector data o GIS shapefile
Software platform compatibility:	Products should be compatible with ArcGIS 10.3 or QGIS
Product accuracy:	1. Sentinel : 25 cm vertical and 10 m horizontal 2. RapidEye: 25 cm vertical and 5m horizontal 3. VHR MS: 25 cm vertical and 1 m horizontal
Service Specifications	
Years of interest:	Not applicable.
Temporal range:	Years 2007-2020. Site#1 1990-2020
Updating frequency:	1 month
Temporal baseline:	1990
Ordering:	Web based ordering system.
Delivery time required:	6 months
Delivery format:	Web-based.
Validation data	

Available at the end-user's premises:	Topographic Lidar surveys in 2007 (OPW) and 2012 (OSI) Topographic lidar survey: Irish railway (2011) – site #3 Orthophotos: : 1995, 2000, 2005,2006 (OPW), 2009, 2011-2013, 2013-2014 (OSI) VHR satellite imagery for selected areas: Wordlview-2 and Pleiades HR Rapid Eye satellite imagery: 2009 to 2016 Tide gauge information VORF (Model) shoreline datum elevation information
Available elsewhere:	High resolution satellite data such as Worldview and Pleiades from ESA archives Digital Globe VHR satellite data Blue Sky airborne topo lidar and orthophotos: https://www.bluesky-world.ie/
Planned collection and when:	AUV photogrammetry data in 2019/2020 Sites 1,2,3,4,5 No planned collection for sites 6,7,8,9,10

Table 16. Product description GSI#4: Elevation transects derived from EO

Description of product no. 4	
General Description	**Elevation transects derived from EO (Sites #1 ,#2,#3,#4,#8,#9#10)**
General service/product description:	Production of elevation transects perpendicular to the coastline from the Backshore to the foreshore using EO data
Uses and benefits:	GSI will use this product to monitor coastal elevation change and slope changes.
Product Specifications	
Spatial scale:	1:5.000
Minimum cell size: (or mapping unit)	1mx1m
Information layers:	Topographic layers with elevation information Date and time of the image used to delineate the tideline Uncertainty in the elevation of the transect Uncertainty in the horizontal location of the transect

Product format:	Vector data XYZ GSI shapefile
Software platform compatibility:	Products should be compatible with ArcGIS 10.3 or QGIS
Product accuracy:	Relative accuracies Sentinel 1 & 2: 25 cm vertical and 5 m horizontal RapidEye: 25 cm vertical and 5m horizontal VHR MS: 25 cm vertical and 1 m horizontal
Service Specifications	
Years of interest:	Not applicable.
Temporal range:	Years 2007 to 2020.
Updating frequency:	Once a year
Temporal baseline:	1990
Ordering:	Web based ordering system.
Delivery time required:	6 months
Delivery format:	Web-based.
Validation data	
Available at the end-user's premises:	Lidar topographic data 2007(OPW), 2012 (OSI) Lidar topography -2011 (Irish Railway) AUV data 2019 (GSI)
Available elsewhere:	○ Blue Sky airborne topo lidar and orthophotos: https://www.bluesky-world.ie/

Planned collection and when:	1- Laser scanning surveys 2019-2020: Sites 1,2,3,4,5,7

Table 17. Product description GSI#5: Monitoring land cover changes

Description of product no. 5	
General Description	**Monitoring of land cover changes sites #3,#4,#8**
General service/product description:	General description of the service and of the information products Various maps of land cover and land use in the back-shore approximately 1000m inland from the waterline sites #3,#4,#8
Uses and benefits:	Classification results will be used to monitor land use changes in the selected areas such as wetland areas dunes and adjacent zones
Product Specifications	
Spatial scale:	1:5000 (only relevant for mapping products)
Minimum cell size: (or mapping unit)	10x10 m (only relevant for mapping products)
Information layers:	Land cover maps: A minimum of 12 classes 1- Forest class 2- Grassland class, 3- Tree plantation class 4- Park and garden class 5- Dune class 6- Salt marsh class 7- Hedge and embankment class 8- Seaweed field class 9- Vegetation-free class 10- Buildings class 11- Cliff class 12: Rock class 13: infrastructure: roads, railway,…

Product format:	o GIS Vector datasets (XYZ) with associated uncertainty (XYZ). o Raster datasets
Software platform compatibility:	Compatible with ARCGIS 10.3 and open source GIS
Product accuracy:	*Confusion matrix > 80%*
Service Specifications	
Years of interest:	
Temporal range:	Between 2000 and 2020
Updating frequency:	4 times a year (Seasonal)
Temporal baseline:	N/A
Ordering:	Web based ordering system.
Delivery time required:	N/A
Delivery format:	.Web-based
Validation data	
Available at the end-user's premises:	Corine land cover EPA reports and maps GSI geology maps: bedrock and soil maps Lidar data from 2007, 2011 and 2012. Orthophotos: 1995, 2000, 2005,2006 (OPW), 2009, 2011-2013, 2013-2014 (OSI)

Available elsewhere:	
Planned collection and when:	None

Table 18. Product description GSI#6 Vegetation line extraction

Description of product no. 6	
General Description Vegetation line extraction for site#1 site #2, site#3 site #4, site#5	
General service/product description:	Vegetation line extraction from VHR satellite optical data (#1x 1m)
Uses and benefits:	GSI will use this product to validate accuracy of automatic detection of the vegetation line in selected areas and to monitor change over time in its position. This is used to assess coastal erosion
Product Specifications	
Spatial scale:	1:5.000
Minimum cell size: (or mapping unit)	1 m x 1 m
Information layers:	Topographic layers with elevation information Topographic layers with elevation information Date and time of the image used to delineate vegetation line Uncertainty in the horizontal location of the vegetation line
Product format:	Vector data XYZ GSI shapefile
Software platform compatibility:	Products should be compatible with ArcGIS 10.3 and QGIS

Product accuracy:	1m horizontal relative accuracies.
Service Specifications	
Years of interest:	Years 2003, 2012 and 2020.
Temporal range:	Not applicable.
Updating frequency:	Once a year
Temporal baseline:	2003
Ordering:	Web based ordering system.
Delivery time required:	6 months
Delivery format:	Web-based.
Validation data	
Available at the end-user's premises:	Lidar topographic data 2007, 2012 Photogrammetry for site #1 and Site #5 GIS vector data of manually digitized vegetation lines from orthophotos for Sites #1 to #5
Available elsewhere:	Not available
Planned collection and when:	Laser scanner at certain locations in sites 1, 2 and 3 (2019 and 2020) AUV surveys on sites 1 to 5 (2019 and 2020)

SPANISH MINISTRY OF ENVIRONMENT (IHCANTABRIA)

Table 19. End-User Organization: SGPC

1. End-User Organization	
Name:	Sub-directorate general for the Coastal Protection (SGPC) of the Directorate General for the Sustainability of the Coast and the Sea (DGSCM) within the Ministry of Ecological Transition (MITECO)
Type of organization:	Public Administration
Description:	The DGSCM aims at protecting the coastal and marine environment and at guaranteeing its free and public use. . It has three major areas of interest, each of them are related to specific Sub-Directorate: • Coastal works • Boundaries and coastal uses • Protection of the marine environment
Department/Division/Section/ Unit	The SGPC is mainly in charge of Coastal Works. Specifically, the following activities of the SGPC are related to this project: • Protection and conservancy of assets in the maritime-terrestrial public domain (coastal public property). In particular, the sustainable management of beaches, dunes, coastal wetlands and the development, supervision, control and survey of studies, projects and works related to coastal defenses. • Enforcement and coordination of plans, programs and measures for the adaptation of the coast to climate change, including the development, supervision, control and survey of studies, projects and works. • Development of technical reports for Environmental Impact Assessment in the coastal areas. • Coordination and enforcement of the Integrated Coastal Zone Management in Spain. The SGPS acts as an end-user. Due to its Public Administration condition the required services and products within this project will be used for coastal management and properly distributed to other interested actors if requested (with the exception of data typified as sensitive for security reasons).
Website	http://www.mapama.gob.es/es/costas/temas/default.aspx
Contact person End-user has delegated its involvement to IHCantabria	**Contact at SGPC:** Ángel Muñoz Cubillo, Deputy Director for the Coastal Protection Ana García-Fletcher., Associate Deputy Director for the Coastal Protection Dirección General de Sostenibilidad de la Costa y del Mar Subdirección General para la Protección de la Costa Plaza San Juan de la Cruz s/n A-840 28071 Madrid

	Tel: +34915976041 email: bzn-sgpcosta@mapama.es & agfletcher@mapama.es **Contact at IHCantabria:** Jara Martínez Sánchez, researcher at the Coastal Engineering and Management Group Instituto de Hidráulica Ambiental, Universidad de Cantabria C / Isabel Torres nº 15 Parque Científico y Tecnológico de Cantabria 39011, Santander Tel: +34942201616 email: medinar@unican.es & martinezj@unican.es

Table 20. Requirements Overview SGPC

2. Requirements Overview	
Description of the requested service:	The expected service and products can be categorized into three major themes: (1) Development of indexes and parameters for the assessment of coastal vulnerability to erosion that can be integrated with precedent existing data (coastal vulnerability to flooding) in currently existing Geographic Information Systems. (2) Products and services for the development of coastal protection action plans. (3) Systematic observations for Coastal Sedimentary and Morphodynamic analysis.
Current Practices:	(1) The SGPS has developed a flood risk management tool in compliance with the Directive 2007/60/EC on the assessment and management of flood risk. It is mainly consisted in Risk-Vulnerability maps at national scale, with profiles every 200 meters for the whole Spanish Coast. Information related to coastal vulnerability to flooding is already available in a web viewer (http://sig.mapama.es/snczi/visor.html?herramienta=DPHZI) but no coastal vulnerability to erosion is publicly available. Coastal vulnerability is currently estimated taking into account parameters such as population, goods or services, evaluating risk as a function of wave climate and coastal evolution. However, there is no systematic obtaining of a Coastal Vulnerability Index (CVI), or other relevant indicators. (2) One of the main concerns of the Spanish Coastal Authority is the implementation of Strategies for Coastal Protection and Adaptation to Climate Change. The decision making process related to coastal protection is currently based on the priorities defined in the Estrategias para la Protección de la Costa (Strategies for Coastal Protection) at specific regions where major erosion problems have been detected (Huelva, Maresme, Castellon, Valencia and Granada completed and Mar Menor, Ebro Delta, Cadiz, Malaga and Almeria under development). Currently, these strategies are based on specific coastal erosion studies and assessments performed at various times in the target areas. The DGSC follows an administration protocol regarding the decision-making under emergencies (repair

	works after storms) but data related to the impacts of storms on the coast is obtained based on a case-by-case approach. (3) The coastal evolution is currently evaluated through sporadic topo-batymetry surveys by the SGPS in particular areas and according to specific needs. The morpho-dynamic related data (shoreline evolution) is usually obtained through orthophotos from various sources, such the IGN. The Instituto Geográfico Nacional (IGN, National Geographical Institute) performs a systematic data collection through the Plan Nacional de Ortofotografía Aérea (PNOA, Nacional Plan for Aerial Orthopotography, http://pnoa.ign.es/vuelo-fotogrametrico), and PNOA-LIDAR for the development of DEM for the whole Spanish territory or other maps. • PNOA-imagen: updated every 3 years with variable resolution (25 and 50 cm). • PNOA-LiDAR: updated every 6 years with variable coverage (minimum current resolution 0.5 points/m2) Currently, the SPGS monitors coastal erosion along the whole Spanish coast through a non-systematical approach. The SGPS develops geophysical surveys along the Spanish coasts to a water depth of 40 m approximately. The various surveys completed since 1987 until recent times were based on diverse technologies and have different coverages and resolutions. The SGPS has also developed "ecocartografías", which include several assessments of biological communities, water quality, cultural heritage, land use and shoreline or topobathymetry mapping, among other information. However, the most recent ecocartografía is dated in 2010 and the spatial coverage is limited to some coastal areas, not the whole Spanish coast. These data is complemented with wave climate information. The wave climate is monitored through the Spanish buoy real-time network and numerical models for weather forecasting.
Motivation and expectation:	Satellite motorization and integration of objective parameters, such as coastal vulnerability index, will allow prompting to continuous evaluation of the coastal zone and to better practice in the decision making process and management (1) The development of a Coastal Vulnerability Index (CVI) in Spain, which would consist of data layers in GIS format that identify coastal areas susceptible to flooding and erosion would enhance the management capabilities of coastal areas. The development of a data set from remote sensing information for the assessment of coastal erosion derived through an erosion susceptibility assessment for various types of coastal features would be the core of the CVI. The Spanish CVI will include but won't be limited to: • Objective parameters from satellite data for the quantification of coastal evolution related to main acting agents such us waves, climate change or infrastructures. • Indicators and metrics derived from satellite data for the identification of coastal assets exposed to coastal erosion and for the characterization of their sensitivity and resilience. • Indicators derived from satellite data for the vulnerability and adaptation to climate change, aligned with the implementation of the Plan Nacional de Adaptación al Cambio Climático (National Plan for the Adaptation to Climate Change) and the Estrategia de Adaptación de la Costa Española

	al Cambio Climático (Strategy for the Adaptation of the Spanish Coast to Climate Change) approved in 2017. These indicators and parameters should be integrated (or at least should be developed to be easily integrated) into the existing Spanish Government Network for sea monitoring and other Geographic Information Systems (GIS) currently available. Special attention will be paid to develop a Spanish CVI comparable with existing CVI in other European countries, so that it facilitates its use in the framework of transnational European coastal management. (2) Products and services that allow to stablish action plans for coastal protection in different time horizons (short-medium-long term): • Development of a tool for the analysis of the efficacy of past coastal protection actions and for the monitoring of recently implemented measures based on satellite information. • Development of methods for the monitoring of land use in coastal areas from satellite data in the past and in the current situation. • Development of an operational system based on satellite imagery and automatic detection of impacts on the coast from both natural and anthropogenic causes (coastal structures, dredging operations…) to improve the capabilities of SGPC to implement the required actions that effectively mitigate the impacts on the coast. The system will be based on systematic coastal monitoring and data processing tools to prompt knowledge and forecasting of coastal evolution trends for different scenarios. • To stablish a transnational system for interchange of sensible data such as mean sea level, oceanic current pattern and other relevant parameters. These data shall be mainly focused on those that have relevant impacts in human and natural life. (3) Systematic and yet affordable observations of coastal morphology (such as those derived from satellite imagery) to provide further insight and a better understanding on coastal systems evolution (beaches and, particularly, deltas). By understanding how coastal systems evolve, the SGPC will be able to better manage sustainable beaches and deltas.

Table 21. Operational Area of Interest SGPC (composed by IHCantabria)

3. Area of Interest	
Name:	Spanish Coastal Zone (Peninsula and Islands)
Type:	Administrative area
Geographical coordinates and size of area of interest:	Latitude: 26.8ºN – 44.04ºN Longitude: 4.57ºE - -18.45ºW Size (km^2): Length (km): Approx. 7.890

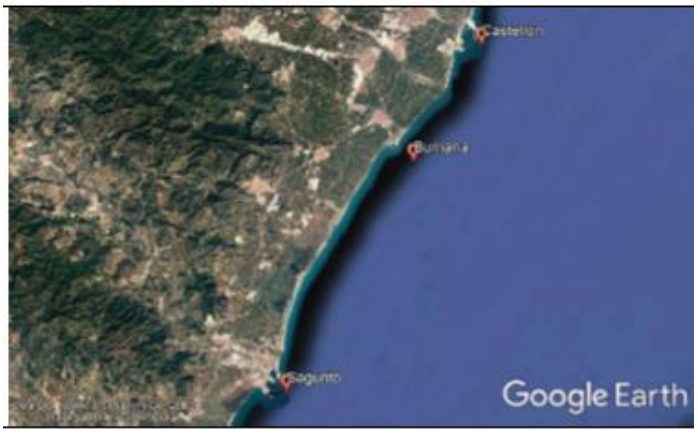
	
Geographical coordinates and size of service demonstration area:	<u>Area #1</u> Name: Spanish Mediterranean Coast and Balearic Islands Latitude: 35.2 N – 42.5 N Longitude:4.3 E – 5.6 W Size (km^2): XX Length (km): Approx. 3470 <u>Area #2</u> Name: Gulf of Cadiz Latitude: 35.9 N – 37.2 N Longitude: 5.6 W – 7.5 W Size (km^2): XX Length (km): Approx. 410 <u>Area #3</u> Name: Cantabrian Sea and Atlantic side of the North of Spain Latitude: 41.8 N – 43.8 N Longitude: 1.8 W – 9.3 W Size (km^2): XX Length (km): Approx. 2430 <u>Area #4</u> Name: Canary Islands Latitude: 27.6 – 29.4 N Longitude: 13.3 W– 18.2 W Size (km^2): XX Length (km): Approx. 1580

Description:	Operational area of interest Spain has around 8.000 Km of coastal areas along the Iberian Peninsula, the Balearic and Canary islands and the cities of Ceuta and Melilla in the north of Africa. In the Cantabrian there are rocky headlands and pocket beaches, sand spits and small estuaries. The Atlantic area on the northwest of the Iberian Peninsula is characterized by rocky coasts and larger estuaries (Rías gallegas) and some sandy beaches in the estuaries or tombolos. In the southwest of the Iberian Peninsula (Gulf of Cadiz), there are long sandy beaches with dunar systems and large wetlands. The Mediterranean coast is characterized by long sandy beaches with low rocky cliffs, a wide variety of coastal structures (groynes, revetments, harbors…), deltas and other features such as La Manga del Mar Menor (a coastal lagoon in the southeast of the Iberian Peninsula). The Balearic islands are mainly composed of rocky coasts and pocket beaches, wetlands and coastal dunes. The Canary islands is characterized by rocky steep shores with high cliffs on the norther of the islands and sandy beaches on the southern areas.
Problems/issues:	All areas Coastal flooding and erosion, urban developments
User organizations:	The SGPC as end user might coordinate the dissemination of the results. IGN, IHM, IGME.
Available data:	Several GIS, Spanish buoy realtime data network, numerical models for wave forecasting, ortophotos, several studies for coastal line and high resolution satellite images, DEM.

Table 22. Operational Area #1 of Interest SGPC (composed by IHCantabria)

3. Area of Interest	
Name:	Spanish Mediterranean Coast and Balearic Islands
Type:	Micro-mareal coastal and deltaic area
Geographical coordinates and size of area of interest:	Latitude: 35.2 N – 42.5 N Longitude:4.3 E – 5.6 W Size (km^2): XX Length (km): Approx. 3470

	
Geographical coordinates and size of service demonstration area:	<u>Site #1</u> Name: Barcelona to Cabo de Gata Latitude: 41º 18’ 43’’ N (Barcelona) – 36º 43’ 03’’ N (Cabo de Gata) Longitude: 2º 10’ 23’’ E – 2º 11’ 36’’ W Size (km^2): XX Length (km): Approx. 900  <u>Site #2</u> Name: Beaches south of Barcelona Latitude: 41º 15’ 20’’ N (Les Botigues), 41º 17’ 30’’ (El Prat) Longitude: 1º 55’ 57’’ (Les Botigues) E, 2º 7’ 32’’ (El Prat)

	Size (km^2): XX Length (km): 3 (Les Botigues) + 8 (El Prat)  <u>Site #3</u> Name: Beaches between the ports of Castellón and Sagunto Latitude: 39º 57’ 1’’ N (Castellon)-39º 37’ 50’’ N (Sagunto) Longitude: 0º 2’ 12’’ E (Castellon)-0º 11’ 52’’ W (Sagunto) Size (km^2): XX Length (km): Approx. 42  <u>Site #4</u> Name: Tordera Delta Latitude: 41º 38’ 42’’ N Longitude: 2º 46’ 59’’ E Size (km^2): XX Length (km): 8

	
Description:	Area #1 The Mediterranean side of Spain is characterized by long sandy beaches with low rocky cliffs, a wide variety of coastal structures (groynes, revetments, harbors…) and low-lying coastal areas such as Ebro Delta. The wave climate is characterized by a small astronomical tidal range; floods are related to storms with high waves and low atmospherical pressures causing storm surge. Coastal erosion in this area can be originated by coastal storms, deficit of sediments downdrift of coastal structures interrupting the littoral drift and a reduction in the sediment yield related to the construction of river dams among other causes. Site #1 The selected service demonstration area is representative of the main features of this coastal zone of the Mediterranean Sea, including a large delta (Ebro Delta), several river mouths and inlets to coastal lagoons, coastal structures (large harbors, small marinas, groynes, seawalls…), long and pocket beaches (sand, gravel or pebble), dunes. Site #2 The beach of El Prat is a sandy beach limited to the east by the groyne at the mouth or Llobregat river. North of the river mouth there is the Port of Barcelona, whose breakwaters modify the wave climate in the beach. The beach is backed by the Llobregat delta with some inlets to several coastal ponds (estanys) and some coastal defenses (rip-rap revetments). About 17 Km downdrift is located the beach of Les Botigues limited to the south by the main breakwater of the Port of Ginesta. It is a sandy beach with low energy wave climate and very small tidal range. Site #3 The area is located between the ports of Castellon and Sagunto, it also includes the marina of Burriana located 12 Km south of Castellón. It is characterized by sandy beaches with some gravels, multiple small groynes, revetments and detached breakwaters. The beaches are backed by urban esplanades, agricultural lands and wetlands. The marine climate is characterized by low energy waves and very small tidal range and a southward littoral drift. Site #4 It is a simple cuspate deltaic sandy shoreline where the northern part is composed by a straight beach (s'Abanell) with a ESE orientation whereas the

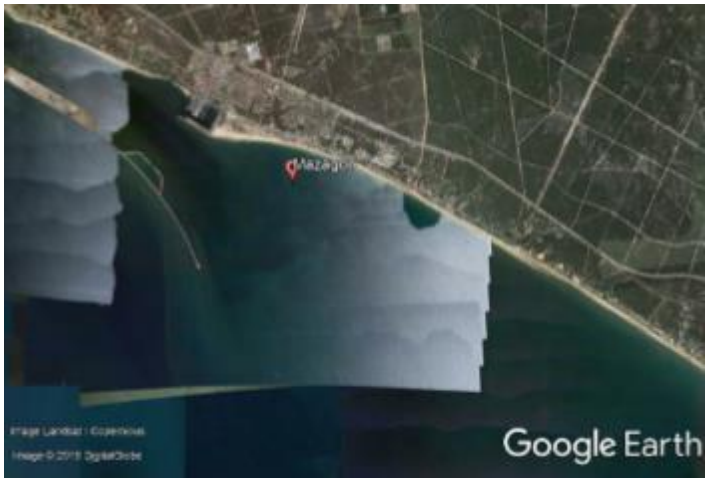
	southern part is orientated SSE. It is located in an areas with moderate wave climate and very small tidal range.
Problems/issues:	Site #1 The main problem of this area is erosion related to several natural and anthropogenic factors. Systematic monitoring of this area through remote sensing techniques is required. Site #2 In order to avoid any impact on the beaches south of the Port of Barcelona after the enlargement the southern breakwater of the port, the Port Authority has conducted periodic (annual or biannual) sand back-passes to guarantee the dynamic equilibrium of the beaches in this pilot area affected by a steady longshore sediment transport from north to south. The works include a monitoring program by means of multi-beam echo sounding of the dredging and disposal areas. Remote sensing techniques can be useful to reduce the cost of such monitoring program. Site #3 A persistent erosion in the area is evident and multiple actions including beach nourishments and construction of coastal structures have been performed during the last few years. The SPCG monitors four different coastal stretches in the area on a regular basis. Remote sensing techniques could be used to monitor the whole area. Site #4 Tordera Delta is highly dynamics, it is directly exposed to the action of the most energetic storm waves in the area (E-NE storms) as well as to those coming from secondary directions (S) and it is one of the most significant hotspots for both storm induced hazards, flooding, and erosion. It has experienced persistent erosion during the last 40 years and the SGPC has been monitoring the area on a regular basis. Remote sensing techniques could reduce monitoring costs.
User organizations:	Site #1 Local authorities or regional government: other public administration and stakeholders interested in the results of the project. Site #2 SGPC (end-user) and Port Authority of Barcelona (in charge of back-passing operations). Site #3 SGPC (end-user), local authorities and regional government Site #4 SGPC (end-user), local authorities and regional government.
Available data:	Site #1 - Periodical monitoring: Beaches south of Barcelona by the Port Authority, coastal stretch between the ports of Castellón and Sagunto by the SGPC. Multi-beam bathymetries of the dredging and disposal area before and after operations since 2007 and on-going once or twice per year. - DEM (5m) and LIDAR (2008-2015, after 2015) by IGN.

	- Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Meteorological station (historical records and operational) at Barcelona airport (AEMET). - Wave buoys (historical records and operational) in Barcelona, Tarragona, Valencia, Cabo de Palos, Cartagena and Cabo de Gata). - Tidal gauges (historical records and operational) in Barcelona, Tarragona, Sagunto, Valencia, Gandía and Carboneras. - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products from the ESA Earthnet catalogue: 139 SPOT1-4 (years 1988-2006), 16 WV2 (2011), 1 IKONOS (2007), 33 Proba1 (2007-2018) and 5 Kompsat2 (2007-2010). - Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and Pleaides images from La Manga to Cabo de Gata (year 2014) - Geology: soil cartography (1:25.000) by ICGC. <u>Site #2</u> - Multi-beam bathymetries of the dredging and disposal area before and after operations since 2007 and on-going once or twice per year. - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Wave buoys (historical records and operational) in Barcelona. - Tidal gauges (historical records and operational) in Barcelona. - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products from the ESA Earthnet catalogue: 5 SPOT1-4 (years 1988-2005), 1 WV2 (2011), 1 IKONOS (2007). - Products of the PNT (Remote Sensing National Plan) by the IGN:7 national coverage SPOT5 (2005-2014) and 1 Pleaides images (year 2014) <u>Site #3</u> - Annual surveys in four different coastal stretches. - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Wave buoys (historical records and operational) in Valencia. - Tidal gauges (historical records and operational) in Sagunto and Valencia. - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products from the ESA Earthnet catalogue: 10 SPOT1-4 (years 1988- 2005). - Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014). <u>Site #4</u>

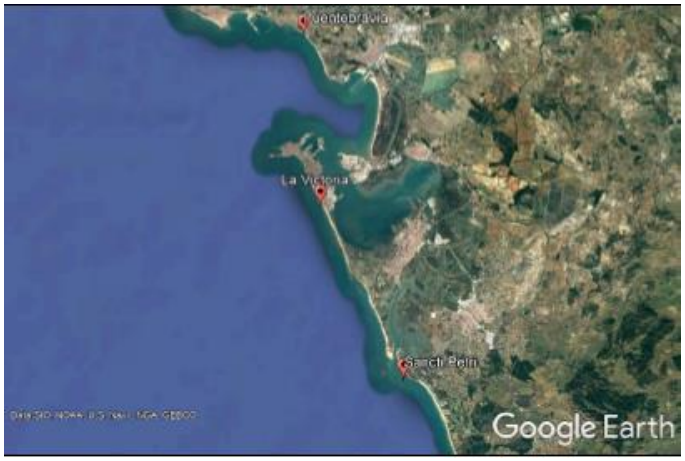
	- Periodical monitoring by the SGPC. - DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Meteorological station (historical records and operational) in Santa Susanna (AEMET). - Wave buoys (historical records and operational) in Barcelona, Cabo de Begur and Palamós). - Tidal gauges (historical records and operational) in Barcelona. - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products from the ESA Earthnet catalogue: 15 SPOT1-4 (years 1988-2007). - Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014). - Soil cartography (1:25.000) by ICGC.

Table 23. Operational Area #2 of Interest SGPC (composed by IHCantabria)

3. Area of Interest	
Name:	Gulf of Cadiz
Type:	Meso-mareal coastal and estuarine area
Geographical coordinates and size of area of interest:	Latitude: 35.9 N – 37.2 N Longitude: 5.6 W – 7.5 W Size (km^2): XX Length (km): Approx. 410

<table>
<tr><td></td><td> 
</td></tr>
<tr><td>Geographical coordinates and size of service demonstration area:</td><td><u>Site #1</u>
Name: Beach of Mazagón
Type: Sandy beach in the Gulf of Cadiz
Latitude: 37º 7’ 15’’ N
Longitude: 6º 48’ 51’’ W
Size (km^2): XX
Length (km): 9
 

<u>Site #2</u></td></tr>
</table>

	Name: Beaches of Cadiz Type: Urban beaches in the Gulf of Cadiz Latitude: 36º 21' 26'' N – 36º 38' 20'' N Longitude: 6º 8' 51'' W – 6º 22' 39'' W Size (km^2): XX Length (km): 10 
Description:	Site #1 The Port of Mazagon and the mouth of the estuary of Huelva (river Odiel) are located on the western boundary of this sandy beach which is connected to other beaches of the same coastal unit until the mouth of the river Guadalquivir, located 50 Km to the east. The western part of the beach is backed by urban developments whereas the easter area is backed by a natural sand dune system and soft small cliffs. The mean spring tidal range in the range is around 3 m and the wave climate is moderate. Site #2 The pilot area include several urban sandy beaches in the bay of Cadiz, namely La Victoria, located between the beach of Santa María del Mar and the beach of Cortadura, Sancti Petri which located by a small marina and Fuentebravía, located inside the Bay of Cadiz by the military base of Rota.
Problems/issues:	Site #1 The beach of Mazagon has experienced an erosion of circa 30 m in the last 20 years. A pipeline (owned by RIPSA and connecting with the gas plant in Campo Poseidon) across the beach has been exposed and re-buried in several occasions. Monthly monitoring of the sub-aerial beach profile along the alignment of the pipeline has been performed since 1998 to monitor the burial depth of the pipeline. Remote sensing techniques could be useful to automatically detect when the pipeline come out of the sand. Site #2 The SPCG performs sand nourishments in all these beaches. Field surveys are performed before and after every intervention. Remote sensing techniques could reduce monitoring costs.
User organizations:	Site #1

	SGPC (end-user), local authorities and regional government, RIPSA (Repsol Investigaciones Petroliferas) gas plant of Campo Poseidon. Site #2 SGPC (end-user), local authorities and regional government.
Available data:	Site #1 - Monthly sub-aerial beach profiles since 1998 and on-going. - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Wave buoys (historical records and operational) in Gulf of Cadiz). - Tidal gauges (historical records and operational) in Huelva. - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and 1 Pleaides (2014). Site #2 - Topobathymetry surveys before and after sand nourishments, including historical regular monitoring in La Victoria during the 90's. - DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Meteorological station (historical records and operational) in Cádiz and San Fernando (AEMET). - Wave buoys (historical records and operational) in Gulf of Cadiz). - Tidal gauges (historical records and operational) in Huelva. - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and 1 Pleaides (2014). - Records of coastal works by Demarcación de Costas de Cádiz. - Ecocartography (2011-2012) by SGPC (sediments, land use).

Table 24. Operational Area #3 of Interest SGPC (composed by IHCantabria)

3. Area of Interest	
Name:	Cantabrian Sea and Atlantic side of the North of Spain
Type:	Macromareal coastal and estuarine area
Geographical coordinates and size of area of interest:	Latitude: 41.8 N – 43.8 N Longitude: 1.8 W – 9.3 W Size (km^2): XX Length (km): Approx. 2430

	
Geographical coordinates and size of service demonstration area:	Site #1 Name: Beach of Salinas Type: Sandy beach and coastal dunes Latitude: 43º 35’ 38’’N - 43º 34’ 54’’N Longitude: 5º 56’ 52’’W – 5º 58’ 14’’W Size (km^2): XX Length (km): 3  Site #2 Name: Beaches of San Sebastian Type: Pocket beaches Latitude: 43º 18’ 58’’ N (La Concha) Longitude: 1º 59’ 22’’ W

	Size (km^2): XX Length (km): 3  3 Name: El Puntal de Santander Type: Sandspit Latitude: 43º 27’ 23’’ N Longitude: 3º 45’ 7’’ W Size (km^2): XX Length (km): 5 
Description:	Area #3 Site #1 Sandy beach located between a rocky headland (La Peñona) to the west and a 400 m-long groyne to the east (at the mouth of the estuary of Avilés). The western half of the beach (in the municipality of San Juan de Navas) is backed by an esplanade and the eastern half (in the municipality of San Juan de Navas) by a coastal dune system (El Espartal). It is a dissipative beach under moderate waves and around 5 m of spring tidal range. It is included in a protected natural area (ZEPA and LIC). Site #2

	Three urban beaches located in the municipality of San Sebastian between rocky headlands and the groynes at the mouth of Urumea estuary and backed by an esplanade. The beaches west of the mouth of the river are under moderate wave energy climate whereas the beach on the east is under high energy wave climate. The spring tidal range is 5 m. Site #3 The estuary of the river Miera in the Bay of Santander is partially enclosed by El Puntal,de Santnader, which is a 2.5 km-long spit of fine sand (median grain size 0.3 mm). The annual average significant wave height (Hs) is about 1 m, with typical winter storm waves of Hs over 5 m. Tides in Santander are semidiurnal with a mean tidal range of 3 m and mean spring tidal range of 5 m.
Problems/issues:	Site #1 Major erosion can occur following winter storms, the SGPC has performed several renourishments and emergency works in the dry beach and in the dunes. The SGPC monitors on a yearly basis the beach, remote sensing techniques could reduce monitoring costs. Site #2 The beaches of San Sebastian experience major erosions due to winter storms.  Evidences of erosion in La Zurrieta after winter storms in 2014. Particularly, cobbles and boulders appear on the sandy beach of Ondarreta on a regular basis after erosional events affecting the use of the beach by locals and tourists. The SPGC monitors these beaches once or twice per year, remote sensing techniques could reduce monitoring cost.3 The natural equilibrium of El Puntal was altered by historical land reclamation inside the Bay of Santander. Over the last 200 years, 50% of the original bay area has been filled, reducing dramatically the tidal prism and, consequently, reducing the tidal currents at the mouth.

This reduction has led to the migration of the equilibrium position of the west end of El Puntal (Punta Rabiosa), narrowing the navigation channel at the mouth of the bay.

For decades, the Port Authority has maintained the navigation channel (required water depth 15m) by means of periodical dredging operations at the end of El Puntal, generating a disequilibrium condition in the spit end. Furthermore, until recent times the dredged sand (thousands of cubic meters) has been disposed outside of the spit system, causing coastal erosion problems at the dunes of Somo.

Nowadays, beach erosion is partially controlled by a sand back-pass (the dredged san from the spit end is pumped to the Loredo/Somo beach) in combination with a dune habitat restoration program (Ammophila Arenaria, Elymus Farctus).

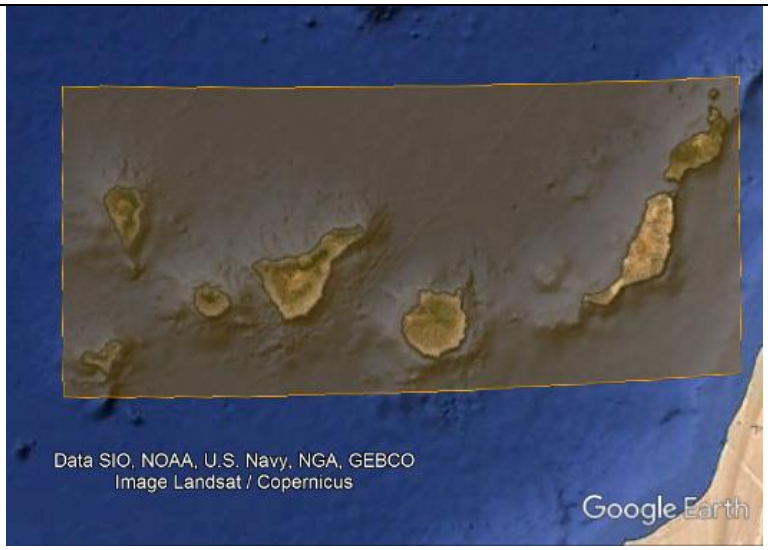
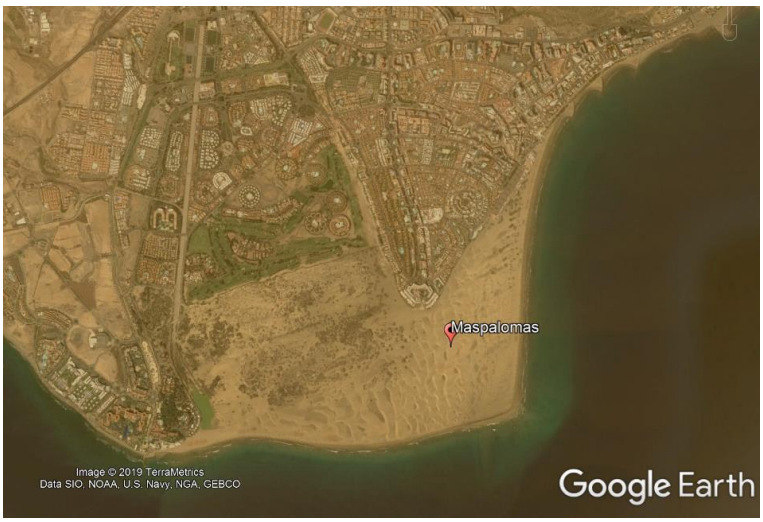
User organizations:	<u>Site #1</u> There could be other public administration and stakeholders interested in the results of the project. Local authorities or regional government.

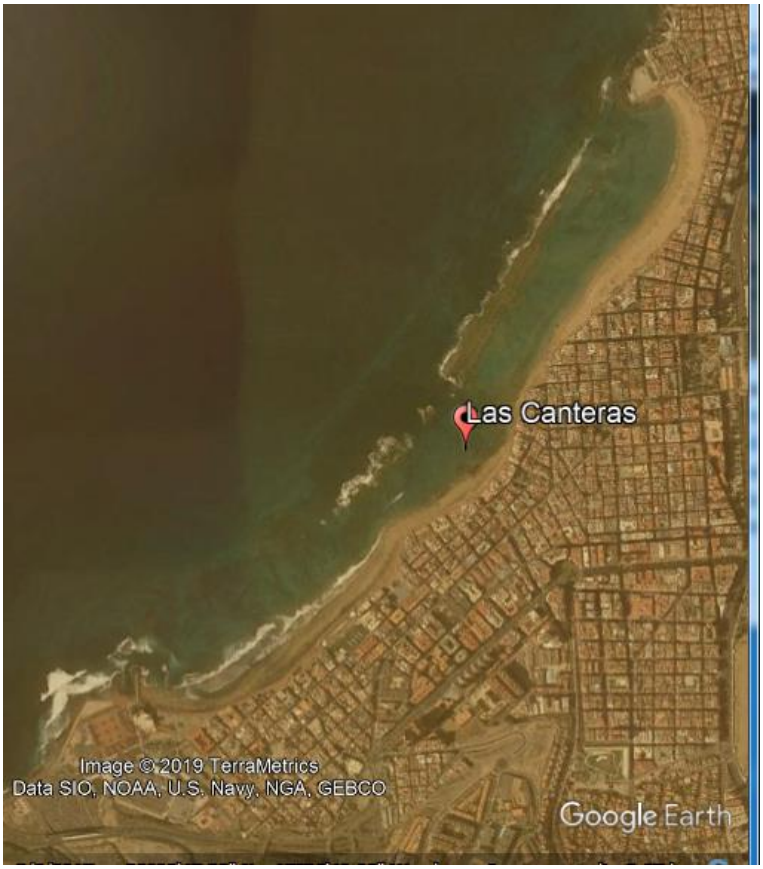
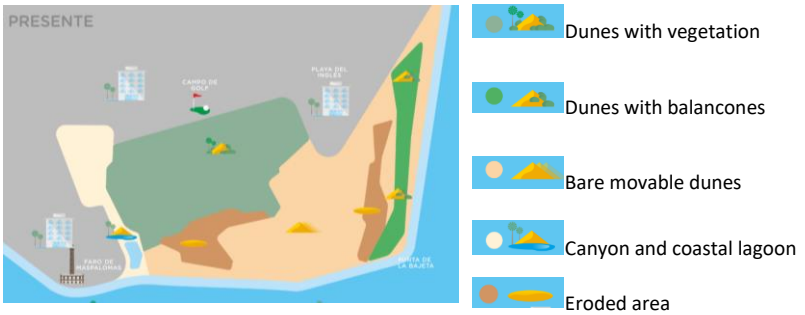
	Site #2 There could be other public administration and stakeholders interested in the results of the project. Local authorities or regional government. Site #3 Santander Port of Authority and other public administrations and stakeholders could be interested in the results of the project. Local authorities or regional government.
Available data:	Site #1 - Several GIS, Spanish buoy realtime data network, numerical models for wave forecasting, ortophotos, several studies for coastal line. - Annual survey of beach topo-bathymetry since 2010 by the SGPC. - DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Meteorological station (historical records and operational) at Asturias Airport (AEMET). - Cabo Peñas Wave buoy (historical records and operational). - Tidal gauges in Gijon and Avilés (historical records and operational). - Wave and surge reanalysis databases (IH-DATA, OPPE). - Products from the ESA Earthnet catalogue: 3 SPOT1-4 (year 2001). - Records of coastal works by Demarcación de Costas de Asturias.Site #2 - Several GIS, Spanish buoy realtime data network, numerical models for wave forecasting, ortophotos, several studies for coastal line. - Topo-bathymetry biannual survey in La Zurriola beach from 1996 to 2005 and annual from 2008 to 2012 by the SGPC. Periodical biannual topo-bathymetry survey of La Concha and Ondarreta beaches (on-going), 4 historical topo-bathymetry surveys (2003-2004) and 70 measurements of dry beach area volume of sediments (1986-2003). - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Pasajes Wave buoy (historical records 2010-2012). - Tidal gauges in Bilbao (historical records and operational). - Wave and surge reanalysis databases (IH-DATA, OPPE). - Meteorological station (historical records and operational) in Zumaia and at San Sebastian Airport (AEMET). - Products from the ESA Earthnet catalogue: 11 SPOT1-4 (years 1988-2006). - CORINE Land Cover 2006 (1:100.000), geomorphology mapping and mapping of forests by GeoEuskadi. Site #3 - Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. - Products from the ESA Earthnet catalogue: 1 WORLDWIEV (year 2011).

	- Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and 1 Pleaides (2014). - Video-camara monitoring system (2008-2014 and 2017-2018). - Meteorological station (historical records and operational) in Santander and at Santander Airport (AEMET). - Wave buoys (historical records and operational) in Santander and Bilbao (OPPE) and wave reanalysis databases (IH-DATA). - Tide gauges (historical records and operational) in Santander (OPPE) and surge reanalysis databases (IH-DATA). - Records of coastal works by Demarcación de Costas de Cantabria. - Records of dredging volumes by Santander Port Authority. - DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. - Several topobathymetry field surveys during the period 1990-1993 and year 2016. - Campaign for the characterization of sediments (IHCantabria, 2017).

Table 25. Operational Area #4 of Interest SGPC (composed by IHCantabria)

3. Area of Interest	
Name:	Canary Islands
Type:	Mesomareal beaches and dunes
Geographical coordinates and size of area of interest:	Latitude: 27.5 N – 29.5 N Longitude: 13.3 W – 18.3 W Size (km^2): XX Length (km): Approx. 1580

	
Geographical coordinates and size of service demonstration area:	<u>Site #1</u> Name: Maspalomas Type: Sandy beach and coastal dunes Latitude: 27º 43’ 30’’N - 27º 45’ 45’’N Longitude: 15º 34’ 45’’W – 15º 33’ 30’’W Size (km^2): 4 Length (km): 5.5  <u>Site #2</u> Name: Las Canteras Type: Pocket beaches Latitude: 28º 07’ 45’’ N - 28º 09’ 00’’ N Longitude: 15º 27’ 00’’ W - 15º 25’ 45’’ W Size (km^2): XX

	Length (km): 2.7 
Description:	Area #4 Site #1 Beach and sand dunes located on the south coast of the island of Gran Canaria (municipality of San Bartolomé de Tirajana). The western half of the beach (Playa de Maspalomas) is oriented towards the south whereas the eastern half of the beach (Playa del Inglés) is oriented towards the east. Punta de la Bajeta is located at the centre of this coastal stretch.  In Playa del Inglés there are primary coastal dunes with Traganum moquinii individuals, which is a local bush that enhances dune formation. West of Playa del Inglés bare movable dunes exist. Between the urban development of Playa

	del Inglés and the Canyon of Maspalomas vegetated dunes exist that are stabilized. This dunar system is unique in the island of Gran Canarias along with the coastal lagoon Charca de Maspalomas (located on the west boundary of the system), which is the most importat wetland in the island. They have been protected as a nature reserve since 1987. Under normal conditions NE winds bring sand into the system through Playa del Inglés, where it is transported inland to form dunes that advance until they reach the sea through Playa de Maspalomas. When storms with heavy SW wind occur, the Maspalomas beach is eroded and the sand is deposited in Punta de la Bajeta, where part of it is lost into the sea. <u>Site #2</u> Las Canteras is located in the northeast of the island of Gran Canaria in the west side of the Guanarteme isthmus, between the rocky headland of La Puntilla to the east and the breakwaters Los Muellitos to the west. The beach is divided in three sections: south (Cicer beach), central (Chica beach) and north (Grande beach). The central and north section is protected by an emerged rocky reef located in front of the beach. All three sections are backed by an esplanade and urban developments. The spring tidal range is 2.5 m. 
Problems/issues:	<u>Site #1</u> Urban developments in Playa del Inglés caused changes in the wind fields increasing the amount of sand leaving the system through the beach of Maspalomas. It is estimated that 45.000 m^3 of sand are lost from the system every year. The environmental degradation of the Maspalomas dunes, including the lost of Traganum moquinii individuals, has been occurring during the last 50 years as a result of touristic overexploitation of its resources. This environmental degradation accelerates dune field erosion.

Traganum moquinii

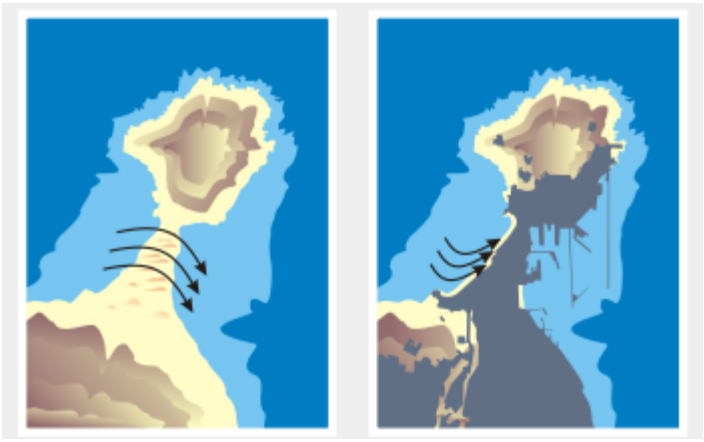
A pilot dune restoration project will be completed by December 2019 (https://masdunas.es) by the island council (Cabildo de Gran Canaria). This project includes the redistribution of sand (ca. 60.000 m3 borrowed from Punta Bajeta and distributed along Playa del Inglés to be completed before the end of 2019), the installation of 51 sand fences, revegetation of dunes with 138 Traganum moquinii individuals and a monitoring system.

Site #2

Until the 19th century the Guanarteme isthmus was covered by a dune field, the wind transported sand from Las Canteras to the east side of the isthmus.

Guanarteme isthmus in 1880.

Currently, the beach of Las Canteras experiences the accumulation of sediments blocked by the urban developments in the isthmus that hinder aeolian sediment transport from the west to the east side.



Previous aeolian sand transport (left) and current accumulation of sand in Las Canteras.

The main accumulation of sand is located in the north of the beach causing the reduction of water depth between the shoreline and the detached reef in front of the beach.

<table>
<tr><td></td><td>In the last 15 years, the SGPC has performed several sand extraction campaigns:
- Year 2003: ca. 35.300 m3 of sand removed from the dry beach.
- Year 2008: ca. 40.400 m3 of sand removed from the intertidal shorefront and dry beach.
- Year 2017: ca. 2.800 m3 redistributed along the physiographic unit.</td></tr>
<tr><td>User organizations:</td><td><u>Site #1</u>

There could be other public administration and stakeholders interested in the results of the project (e.g. restoration project https://masdunas.es). Regional government or local authorities, e.g. Cabildo insular de Gran Canaria (Gran Canaria island council), municipality of San Bartolomé de Tiraja.

<u>Site #2</u>

There could be other public administration and stakeholders interested in the results of the project. Regional government or local authorities, e.g. Cabildo insular de Gran Canaria (Gran Canaria island council), municipality of Las Palmas de Gran Canaria.</td></tr>
<tr><td>Available data:</td><td><u>Site #1</u>

- Several studies. DEM, LIDAR and topography from the project Masdunas (https://masdunas.es)

- Bathymetry (up to 50 m depth), shoreline and sediment characterization in 2000 (https://www.miteco.gob.es/es/costas/temas/proteccion-costa/ecocartografias/ecocartografia-laspalmas.aspx).

- DEM (5m) and LIDAR (2008-2015, after 2015) by IGN.

-DEM (2.5m) and LIDAR including land cover (urban and vegetated) 2011-2012 by IDECanarias.

- Ortophotos fromPNOA with 0.2-0.25 m of horizontal resolution in 2018, 2015, 2012, 2009 and 2005. Scatter historical ortophotos since 1929 (GRAPHCAN).

- Infrared picture (0.2 m) from aerial photography (years 2006 and 2018).

- Meteorological station (historical records and operational) at San Sebastian de Tirajana (AEMET).

- La Palma Este and Gran Canaria Wave buoys (historical records and operational).

- Tidal gauges in Las Palmas (historical records and operational).

- Wave and surge reanalysis databases (IH-DATA, OPPE).

- Products from the ESA Earthnet catalogue

- Land use map (E:1:25.000) year 2002 by IDECanarias.

<u>Site #2</u>

- Several specific studies:

<table>
<tr><th>Author</th><th>Date</th><th>Area covered</th></tr>
<tr><td>Ahinco</td><td>June 1978</td><td>Topobathymetry of complete beach</td></tr>
<tr><td>Prointec</td><td>December 1984</td><td>Bathymetry of complete beach</td></tr>
</table>
</td></tr>
</table>

J. M. Montero	June 1993	Topobathymetry of complete beach
I. Alonso	Monthly 1987-1992	Topography of subaerial and intertidal beach
A. Bolaños y S. Santana	August 1996	Topography of central and north sections
E. Copeiro y M.J. García	2002	Topography of north section
R. Medina et al.	August 2006	Topography of central and north sections
M. Escalada y I.P. Gómez	October 2007	Topobathymetry of south and north sections
Demarcación de Costas	November 2012	Topography of subaerial and intertidal beach of north section
I. Alonso et al.	Monthly 2014- 2015	Topobathymetry up to 2 m Depth
Elittoral	2018	Topobathymtry of submerged beach

- Bathymetry (up to 50 m depth, year 2006) and topography (year 2003, 2004-2005) by MITECO (Estudio Ecocartográfico Zona Norte Isla de Gran Canaria, 2018).

- DEM (5m) and LIDAR (2008-2015, after 2015) by IGN.

-DEM (2.5m) and LIDAR including land cover (urban and vegetated) 2011-2012 by IDECanarias.

- Ortophotos fromPNOA with 0.2-0.25 m of horizontal resolution in 2018, 2015, 2012, 2009 and 2005. Scatter historical ortophotos since 1929 (GRAPHCAN).

- Infrared picture (0.2 m) from aerial photography (years 2006 and 2018).

- Meteorological station (historical records and operational) in Arucas.

- La Palma Este and Gran Canaria Wave buoys (historical records and operational).

- Tidal gauges in Las Palmas (historical records and operational).

- Wave and surge reanalysis databases (IH-DATA, OPPE).

- Products from the ESA Earthnet catalogue

- Land use map (E:1:25.000) year 2002 by IDECanarias.

Table 26. Product description SGPC #1: Monitoring of bathymetric changes in beaches

Description of product no. 1

General Description and Las Canteras	**Monitoring of bathymetric changes in the beaches south of Barcelona, Mazagon**
General service/product description:	Various SDB up to 15 m depth in the coastal stretch of Site 2 in Area 1 (Beaches south of Barcelona) and Site 1 in Area 2 (Beach of Mazagon).
Uses and benefits:	The SGPC will use this product to assess the efficacy of the back-pass of sediments performed by Barcelona Port Authority from the downstream area (dredged area north of Port Ginesta) to the upstream area (disposal area at El Prat). In Mazagon, the subaerial beach profile is highly conditioned by the 3D coastal dynamics of submerged sandbars systems, which vary from transverse to crescentic. This product will complement monthly subaerial beach profiles (undertaken regularly since 1998) along the alignment of a gas pipeline buried on the beach towards a proactive management that prevents the exposure of the pipeline. In Las Canteras accumulation of sand in the north section of the beach, between the shorefront and the rocky detached reef has required sand extraction campaigns by the SGPC, who will use this product to assess the efficacy of these actions and to estimate the sedimentation rates in the beach in order to plan new actions.
Product Specifications	
Spatial scale:	1:5.000
Minimum cell size: (or mapping unit)	1mx1m
Information layers:	Bathymetry maps of the dredging and disposal area before and after each back-passing (historic and on-going).
Product format:	○ Vectors for X, Y, Z and uncertainty for Z in shapefile format for each map (several dates x before and after x dredging and disposal area).
Software platform compatibility:	Products should be compatible with ArcGIS 10.4.

Product accuracy:	10 cm vertical and 1 m horizontal relative accuracies.
Service Specifications	
Years of interest:	Not applicable.
Temporal range:	Years 2007-2020 in Barcelona. Years 1998-2020 in Mazagon. Years 1984-2020 in Las Canteras
Updating frequency:	Monthly.
Temporal baseline:	Not applicable.
Ordering:	Web based ordering system.
Delivery time required:	Less than 1 week
Delivery format:	Web-based.
Validation data	
Available at the end-user's premises:	Bathymetry field surveys twice a year for the period 2007-2018 in Barcelona. Monthly sub-aerial beach profiles since 1998 and on-going in Mazagon. Specific studies in las Canteras (multiple dates, see Table 25), and bathymetry by MITECO in 2006.
Available elsewhere:	o Not applicable.
Planned collection and when:	Barcelona Port Authority is to perform bathymetry field surveys in 2019 and 2020. RIPSA is to perform monthly sub-aerial beach profies bathymetry field surveys in 2019 and 2020 in Mazagon.

Table 27. Product description SGPC #2: Monitoring shoreline changes in beaches

Description of product no. 2	
General Description	**Monitoring shoreline changes in the beaches South of Barcelona, the mouth of the Tordera Delta, Cadiz, Salinas, San Sebastian, El Puntal de Santander, Las Canteras and Maspalomas**
General service/product description:	Various shoreline extractions in the coastal stretch of Site 2 in Area 1 (Beaches south of Barcelona), Site 4 in Area 1 (Tordera Delta), Site 2 in Area 2 (Beaches of Cadiz), Site 1 in Area 3 (Beach of Salinas, including the identification of the dune foot), Site 2 in Area 3 (Beaches of San Sebastian) and Site 3 in Area 3 (Puntal de Santander, including the identification of the dune foot).
Uses and benefits:	The SGPC will use this product: • to assess the efficacy of the back-pass of sediments performed by Barcelona Port Authority from the downstream area (dredged area north of Port Ginesta) to the upstream area (disposal area at El Prat) of the coastal stretch in Site 2 of Area 1. • to assess the efficacy of the sand back-pass that is currently being performed by Santander Port Authority at El Puntal (Site 3 of Area 3). • to improve understanding of coastal morphodynamics along the Tordera Delta (Site 4 of Area 1) at two timescales: interannual evolution and short-term response to storms. This knowledge is the first step towards the development of an action plan targeting both, the regular maintenance works and the provision of emergency works in this site. • to inform the strategies for the coastal protection of Cadiz (currently under development). • to inform their management decision and to design regular maintenance and emergency works in Salinas and San Sebastian. • to assess accretional rates in Las Canteras. • to improve understanding of coastal changes in Maspalomas.
Product Specifications	
Spatial scale:	1:5.000
Minimum cell size: (or mapping unit)	1mx1m
Information layers:	Shoreline position polylines of the whole coastal stretch in Site 2 of Area 1, Site 4 of Area 1, Site 2 of Area 2, Site 1 of Area 3, Site 2 of Area 3, Site 3 of Area 3, Site 1 of Area 1 and Site 2 of Area 4 at several dates.
Product format:	o Vectors for X, Y and uncertainty in the cross-shore position in shapefile format for each map (several dates, monthly and right after major storms).

Software platform compatibility:	Products should be compatible with ArcGIS 10.4
Product accuracy:	1 m horizontal relative accuracy.
Service Specifications	
Years of interest:	Not applicable.
Temporal range:	Years 2007-2020 in Barcelona. Years 2000-2020 in Tordera Delta. Years 1990-2020 in Cadiz and El Puntal de Santander. Years 2010-2020 in Salinas. Years 1995-2020 in San Sebastian. Years 1984-2020 in Las Canteras Years 2000-2020 in Maspalomas
Updating frequency:	Seasonal (4 times a year) in Barcelona, Salinas, San Sebastian and El Puntal de Santander. Monthly in Tordera Delta, Cadiz, Las Canteras and Maspalomas. Right after major storms (upon request) in Tordera Delta, Cadiz, Salinas, San Sebastian and El Puntal de Santander.
Temporal baseline:	Not applicable.
Ordering:	Web based ordering system.
Delivery time required:	Less than one week for the monthly products, less than two days for the shorelines after major storms (upon request).
Delivery format:	Web-based.
Validation data	
Available at the end-user's premises:	o Bathymetry field surveys in Barcelona twice a year for the period 2007-2018. o Periodical monitoring by the SGPC in the Tordera Delta. o Topobathymetry surveys before and after sand nourishments, including historical regular monitoring in La Victoria during the 90's. o Annual survey of beach topo-bathymetry since 2010 by the SGPC in Salinas and San Sebastian.

	○ Various shorelines before 1995 by the CEDEX. ○ Several topobathymetry field surveys during the period 1990-1993 and year 2016 at El Puntal de Santander. ○ Video-camara monitoring system (2008-2014 and 2017-2018) at El Puntal de Santander. ○ Shoreline by MITECO in 2000 in Maspalomas. ○ Specific studies in Las Canteras (multiple dates, see Table 25), and shoreline by MITECO in 2006.
Available elsewhere:	In Barcelona: ○ Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. ○ Products from the ESA Earthnet catalogue: 5 SPOT1-4 (years 1988-2005), 1 WV2 (2011), 1 IKONOS (2007). ○ Products of the PNT (Remote Sensing National Plan) by the IGN:7 national coverage SPOT5 (2005-2014) and 1 Pleaides images (year 2014) In Tordera Delta: ○ Products from the ESA Earthnet catalogue: 15 SPOT1-4 (years 1988-2007). ○ Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014). In Cádiz: ○ DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. ○ Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. ○ Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and 1 Pleaides (2014). In Salinas: ○ DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. ○ Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. ○ Products from the ESA Earthnet catalogue: 3 SPOT1-4 (year 2001). In San Sebastian: ○ DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. ○ Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. ○ Products from the ESA Earthnet catalogue: 3 SPOT1-4 (year 2001). In El Puntal de Santander: ○ DEM (5m) and LIDAR (2008-2015, after 2015) by IGN.

	○ Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. ○ Products from the ESA Earthnet catalogue: 1 WORLDWIEV (year 2011). ○ Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and 1 Pleaides (2014). In MasPalomas: ○ Several studies. DEM, LIDAR and tipography from the project Masdunas (https://masdunas.es) ○ DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. ○ DEM (2.5m) and LIDARin 2011-2012 by IDECanarias. ○ Ortophotos fromPNOA with 0.2-0.25 m of horizontal resolution in 2018, 2015, 2012, 2009 and 2005. Scatter historical ortophotos since 1929. ○ Infrared picture (0.2 m) from aerial photography (years 2006 and 2018). ○ Products from the ESA Earthnet catalogue. In Las Canteras: ○ DEM (5m) and LIDAR (2008-2015, after 2015) by IGN. ○ DEM (2.5m) and LIDAR in 2011-2012 by IDECanarias. ○ Ortophotos fromPNOA with 0.2-0.25 m of horizontal resolution in 2018, 2015, 2012, 2009 and 2005. Scatter historical ortophotos since 1929. ○ Infrared picture (0.2 m) from aerial photography (years 2006 and 2018). ○ Products from the ESA Earthnet catalogue.
Planned collection and when:	Barcelona Port Authority is to perform bathymetry field surveys in 2019 and 2020. The SGPC is to perform annual topo-bathymetry in 2019 and 2020 in Salinas, San Sebastian.

Table 28. Product description SGPC #3: Monitoring of land cover changes

Description of product no. 3	
General Description	**Monitoring of land cover changes in the Tordera Delta, Salinas, San Sebastian, El Puntal de Santander and Maspalomas**
General service/product description:	Various maps of land cover and land use in the back-shore (a minimum of 150 m inland) of Site 3 in Area 1 (Tordera Delta), in the subaerial beach up to the seawall of Site 2 in Area 3 (San Sebastian) and the whole dune system

	in Site 1 in Area 3 (Salinas), Site 3 in Area 3 (El Puntal de Santander) and Site 1 in Area 4 (Maspalomas).
Uses and benefits:	The beaches of the Tordera Delta have experience a systematic erosion that led to the removal of some houses located on the shorefront. Hard structures, soft engineering structures and revegetation of the backshore have been implemented in the area. These products will help to assess the efficacy of such measures. The SGPC will use this product to assess the efficacy of the dunes revegetation that is currently being performed in El Puntal de Santander and in Maspalomas. Finally, the SGPC will use this product to inform their management decision and to design regular maintenance and emergency works in Salinas, San Sebastian. Particularly, this product aims to detect the presence of cobbles and boulders at the beach of Ondarreta (San Sebastian).
Product Specifications	
Spatial scale:	1:5.000
Minimum cell size: (or mapping unit)	1mx1m
Information layers:	Land cover maps including: beach (sandy, gravel, cobbles, boulders), rocks, vegetation (several types such as scarce dune vegetation, forest, grassland and others), rip-rap revetments, urban and others for various dates.
Product format:	Raster files in GeoTiff format for the land-cover layer supported by a metadata file including ancillary information on accuracy, data used, etc (several dates).
Software platform compatibility:	Products should be compatible with ArcGIS 10.4.
Product accuracy:	1 m horizontal relative accuracies.
Service Specifications	
Years of interest:	Not applicable.

Temporal range:	Years 2000-2020 in Tordera Delta. Years 2010-2020 in Salinas. Years 1995-2020 in San Sebastian. Years 1990-2020 in El Puntal de Santander. Years 2000-2020 in Maspalomas.
Updating frequency:	Seasonal (4 times a year) in Salinas, San Sebastian, El Puntal de Santander and Maspalomas. Monthly in Tordera Delta. After major storms (upon request) in Salinas, San Sebastian and El Puntal de Santander.
Temporal baseline:	Not applicable.
Ordering:	Web based ordering system.
Delivery time required:	Less than two days for the shorelines after major storms (upon request).
Delivery format:	Web-based.
Validation data	
Available at the end-user's premises:	o Periodical monitoring by the SGPC in Tordera Delta.
Available elsewhere:	In all sites: o Ortophotos fromPNOA with 0.25-0.5 m of horizontal resolution and a periodicity of 2-3 years since 2004.Scatter historical ortophotos since 1929. o Land use maps and land cover by SIOSE. In Tordera Delta: o Soil cartography (1:25.000) by ICGC. o Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014). In Salinas: o Products from the ESA Earthnet catalogue: 3 SPOT1-4 (year 2001). In San Sebastian: o Products from the ESA Earthnet catalogue: 11 SPOT1-4 (years 1988-2006).. o CORINE Land Cover 2006 o Geomorphology mapping and mapping of forests by GeoEuskadi.

	In El Puntal de Santander: o Products from the ESA Earthnet catalogue: 1 WORLDWIEV (year 2011). o Products of the PNT (Remote Sensing National Plan) by the IGN: 7 national coverage SPOT5 (2005-2014) and 1 Pleaides (2014). In Maspalomas: o Scatter historical ortophotos since 1929 (GRAPHCAN). o Infrared picture (0.2 m) from aerial photography (years 2006 and 2018). o Land use map (E:1:25.000) year 2002 by IDECanarias.
Planned collection and when:	Not applicable.

GOUVERNEMENT DU QUÉBEC (ARCTUS)

Table 29. End-User Organization: Government of Québec (ARCTUS)

1. End-User Organization	
Name:	Government of Québec
Type of organization:	Governmental organization
Description:	The Government of Québec is the political authority that governs Québec. To assess the coastal erosion rates, impact and resilience the government composed by his Ministry fund experts to help for decision-making.
Department/Division/Section/Unit	Three departments are specifically involved in the coastal erosion monitoring: • Department of Public Security; Ministère de la Sécurité Publique (MSP) • Department Sustainable Development, Environment and the Fight against Climate Change ; Ministère du Développement Durable, Environnement et Lutte contre les Changements Climatiques (MDDELCC) • Ministry of Transport, Sustainable Mobility and Transportation Electrification; Ministère des Transports, de la Mobilité durable et de l'Électrification des transports (MTQ) The MSP mission is to ensure the public safety in Quebec. Through its role within the government apparatus, the MSP is called to assess and reduce the vulnerability of Quebecer to the risks related to disasters. The following activities of the MSP are related to this project: • Territorial monitoring of the coastal erosion. Every year, coastal erosion poses a significant threat to riparian lands and infrastructure. This phenomenon particularly affects the shoreline of the St. Lawrence downstream Quebec and in the Gulf of St. Lawrence. • Providing support to municipalities and public organization in coastal erosion monitoring and disaster responses. The MDDELCC mission is to contribute to Quebec sustainable development by playing a key role in the fight against climate change, protecting the environment and conserving biodiversity for the benefit of citizens. The following activities of the MDDELCC are related to this project: • Assessment of the coastal vulnerability of the local communities. The MTQ is mandated to ensure, throughout the territory, the sustainable mobility of people and goods through efficient and safe transportation systems that contribute to the development of Quebec. In the current context, coastal erosion and flooding cause problems for some provincial roads (274 road segments) are currently being followed by the Ministry of Transport of Québec in regard to the problem of erosion.
Website	MTQ: https://www.transports.gouv.qc.ca/fr/Pages/default.aspx MSP: https://www.securitepublique.gouv.qc.ca/securite-civile/surveillance-du-territoire/erosion-cotiere.html MDDELCC:

	http://www.mddelcc.gouv.qc.ca/rapportsurleau/Etat-eau-ecosysteme-aquatique-rivesCotes-Quelle-situation_EstuaireGolf.html
Contact person End-user has delegated its involvement to ARCTUS	**Contact at MTQ** Michel Michaud, Conseiller en recherche Service de la coordination de la recherche et de l'innovation Direction de l'environnement et de la recherche Ministère des Transports du Québec 930, chemin Ste-Foy, 6e étage Québec (Québec) G1S 4X9 Tel: (418) 644-0986 poste 4161 Fax: 418 643-0345 email: michel.michaud@mtq.gouv.qc.ca **Contact at MSP** Josée Desgagné, géo. M.A.P., Conseillère en gestion des risques naturels Service de l'expertise Direction générale de la sécurité civile et de la sécurité incendie Ministère de la Sécurité publique 3950 boulevard Harvey, RC-03 Jonquière (Québec) G7X 8L6 Tel: (418) 695-7872 poste 42220 Fax: (418) 695-7875 **Contact at MDDELCC** Francis Bourret, biologiste, M. Sc. Direction de l'agroenvironnement et du milieu hydrique Direction générale des politiques de l'eau Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques Édifice Marie-Guyart, 8e étage, boîte 42 675, boulevard René-Lévesque Est Québec (Québec) G1R 5V7 Tel: (418) 521-3885, poste 4971 email: francis.bourret@mddelcc.gouv.qc.ca **Contact at ARCTUS** Thomas Jaegler, MSc. Ecology

	Local : F-412 UQAR Tel: (418) 723-1986 poste 1167 email: tj@arctus.ca

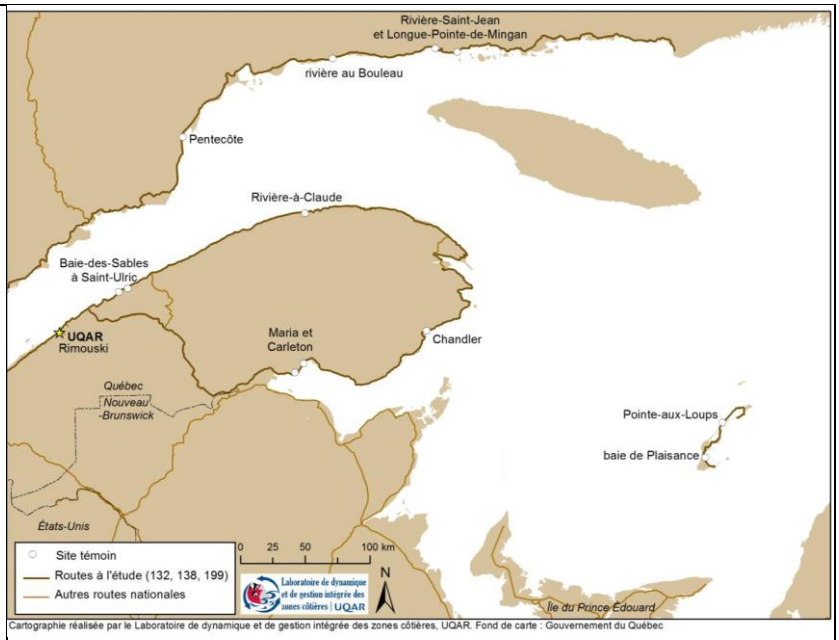
Table 30. Requirements Overview: Government of Québec (ARCTUS)

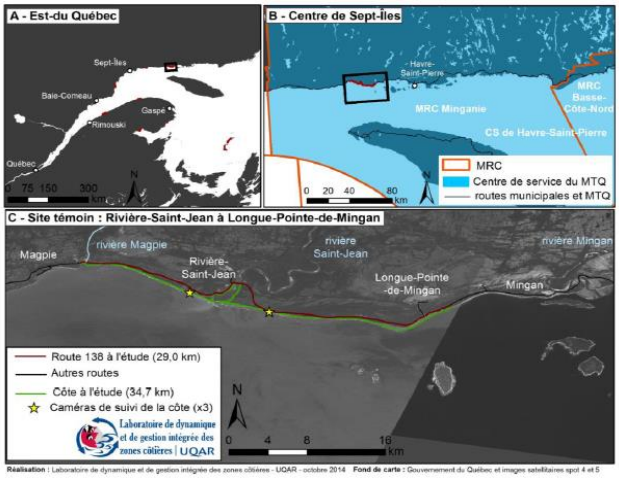
2. Requirements Overview	
Description of the requested service:	Acquiring knowledge on coastal erosion dynamics in order to mitigate the impacts of these natural phenomena, particularly on the communities that occupy the shores and coasts. (1) Acquire the near shore coastal bathymorphology derived from satellite observation and assess changes due to erosion. (2) Assessment of coastal erosion impact on the sediment volume changes. (3) Assessment of coastal erosion impact on the shoreline/waterline. (4) Land use and landcover maps to assess the changes and loss of land and infrastructure due to coastal erosion. Propose a web-based platform to disseminate EO product to help communities, municipalities and decision makers.
Current Practices:	In Quebec 43% of the coastal zone (~ 3000 km) is potentially at risk for submersion. A large part of the population and infrastructure (270 km of roads, bridge, and 26 km of railways) representing 776 M$ are localized in the coastal zone. More than a third of the population of Québec maritime lives within 500 m from the shores of the St. Lawrence and more than 90% within 5 km (Bourque and Simonet, 2008). In addition, nearly 60% of national roads are located in less than 500 m from the coast (Drejza et al., 2014). Knowing and manage the risks associated with bank erosion occupies a place more and more important in local, regional and provincial discussions and decisions. To acquire the information needed to help the decision maker and administration a Coastal Erosion Monitoring Network has been put in place along the coast of the St. Lawrence: Quebec Coastal Erosion Monitoring Network. Since 2003, the Government of Québec funded the Laboratoire de Dynamique et de Gestion Intégrée des Zones Côtières (LDGIZC) to manage a network of 6400 periodic coastal profiles distributed on the various types of coastal systems of the Estuary and the Gulf of St Lawrence. This network helps to know precisely the advance and/or the retreat of the Quebec maritime coasts in order to improve the understanding of coastal systems and provide decision support for coastal management. The aim of the coastal erosion network is: • to quantify the shoreline shift to assess its sensitivity; • to quantify the coastal retreat during extreme events; • to determine the spatial variability in the speed of the shoreline displacement according to geomorphological and marine characteristics; • determine the temporal variability in the shoreline movement rate and evaluate the presence of cycles in evolution trends; • identify the processes and causes of coastal erosion and sedimentation; • assess the vulnerability of coastal infrastructure to coastal hazards;

	• quantify and update the event-driven maximum setbacks for coastal erosion safety margin mapping. This network makes it possible to measure the variability spatial and temporal of the erosion and submersion processes and the coastal environmental changes of the St. Lawrence. The Système Intégré de Gestion de l'Environnement Côtier (SIGEC WEB) was developed in 2003 to provide access to a geographic information system via a user-friendly web link and to disseminate information to authorities and stakeholders involved in coastal management. This portal provides to municipalities, administration and ministries a tool to support decision for the sustainable management of Quebec, taking into account the coastal hazards and climate change. This system integrates a mosaic of orthorectified and georeferenced aerial photography of the entire shoreline of the Estuary and the Gulf of St. Lawrence. These images were used to digitize the coastal evolution at a high resolution (0.10 m). The integration of biophysical, social, cultural, economic and environmental multisource data into SIGEC allows for sophisticated digital processing and spatial analyzes. This interactive tool allows sharing maps in addition to providing the opportunity for users to produce and distribute their own maps.
Motivation and expectation:	Fill the remaining gaps in the coastal erosion process to have better estimates of net sediment gains and losses. The capacity of mapping frequently (~1 per month) the bathymetry between ~5 to 10 m has the potential to fill our current understanding about a dynamic sector. End users (MTQ, MSP, MDDELC) will benefit by having this knowledge which will lead to a better-informed decision. Combining with the beach profile measurement and near real-time camera acquisition will provide excellent estimation of sedimentary movement and budget. Repeated bathymetry measurements and sedimentary budget will help to better understand the dynamics of beach and evaluate the vulnerability of the near-road infrastructure.

Table 31. Area of Interest: Government of Québec (ARCTUS)

3. Area of Interest	
Name:	St Lawrence gulf and Estuary coast.
Type:	The St-Lawrence coastline is characterized by many types of coastal environment such as Maritime march, beach terrace, coastal spire, moving cliffs, rocky cliffs and artificial coastline (definition can be found in Drejza et al 2014). Unconsolidated, low-lying coasts consisting of salt marshes, sandy barrier islands and beaches occur mainly along the St. Lawrence estuary and western shores of the Gulf of St. Lawrence (Quebec, Prince Edward Island and New Brunswick) and on the Îles de la Madeleine, as well as along the Bay of Fundy, especially at its head. About, 43% of the coastline maritime Quebec would potentially be at risk of submersion, of which 31% Côte-Nord coastline, 66% for the Bas-Saint-Laurent region, 39% for the Gaspésie and 70% in the Magdalen Islands. In addition, almost 50% of the coast eastern Quebec are susceptible to erosion (excluding coasts Igneous rocks) (Drejza et al., 2014).

	 Figure 1: St-Lawrence gulf and estuary coastline with major road. DREJZA, S., FRIESINGER, S., P. BERNATCHEZ et G. MARIE (2014), **Vulnérabilité des infrastructures routières de l'Est du Québec à l'érosion et à la submersion côtière dans un contexte de changements climatiques** : Développement d'une approche et d'un indice pour quantifier la vulnérabilité des infrastructures routières à l'érosion et à la submersion côtière dans un contexte de changements climatiques sur 9 sites témoins. **Volume III. Projet X008.1.** Laboratoire de dynamique et de gestion intégrée des zones côtières, Université du Québec à Rimouski. Remis au ministère des Transports du Québec, mars 2015, 308 p
Geographical coordinates and size of area of interest:	Québec city location Latitude:46.806166Longitude:-71.2939300Size (km^2): 1 542 056
Geographical coordinates and size of service demonstration area:	Site #1 Coastal area around the St-Jean River at longue pointe de Mingan. Latitude: 50.2584 Longitude: -64.3946 Size (km^2): 45 Site #2 Peninsula between the Manicouagan river estuary and the Aux-Outardes river Latitude: 49.1570 Longitude: -64.274656 Size (km^2): 67 Site #3 Pointe au Loup / Cap aux Meules - Îles-de-la-Madeleine - Gulf of St Lawrence Latitude: 47.52857

	Longitude: -61.705698 Size (km^2): 11 <u>Site #4</u> Pointe au Loup / Cap aux Meules - Îles-de-la-Madeleine - Gulf of St Lawrence Latitude: 47.395527 Longitude: -61.836362 Size (km^2): 5 km^2
Description:	<u>Site #1</u> The first operational area of interest is located on the north shore of the St. Lawrence between St. Jean River and the sector of Longue pointe de Mingan (Figure 1). The coast of the operational area of interest is 27 km long and almost half of it consists of beaches (17.1 km or 49.1%). These are located almost exclusively east of the Saint-Jean River. The movable cliffs (11.1 km or 31.9%) and the low movable cliffs (2.7 km or 7.8%) are located west of the river and at its mouth. The average historical erosion rate for the case site is -1.97 m/year between 1948 and 2005. Between 200-2017 mean annual rate = -1.39 m/y.  Figure 3: Operational area of service requested extends from river St. Jean to Longue-Pointe-de-Mingan instrumented sector. <u>Site #2</u> The second demonstration site (site #2) is located on the north shore of the St. Lawrence on a Peninsula between the Manicouagan river estuary and the Aux-Outardes river. (Figure 2). The coast of the site 2 is 28 km long and most of it consists of movable cliffs. On the Manicouagan Peninsula, erosion rates ranging from -0.1 to -3.6 m / year for about 70 years (Grondin et al., 1990 ;

Bernatchez et Baker, 1995 ; Bernatchez, 1998, 2000, 2003a ; Dubois, 1999) ; For the last decade it erosion rate increase to -7 m/y on the sandy beach (Bernatchez, 2003a).

Figure 3: Operational site #2 extends from Pointe-aux Outardes to Pointe Lebel. Extend of case study sites between the two pins.

Site #3 and #4

The third demonstration site (site #3) is Pointe-aux-Loup which is located on the Magdalen Island (QC). This is the main populated island of the archipelago. The site#223extends around Pointe-aux-Loup to Cap de l'Hopital in the south to Cap au Dauphin in the north with a length of 39 km.

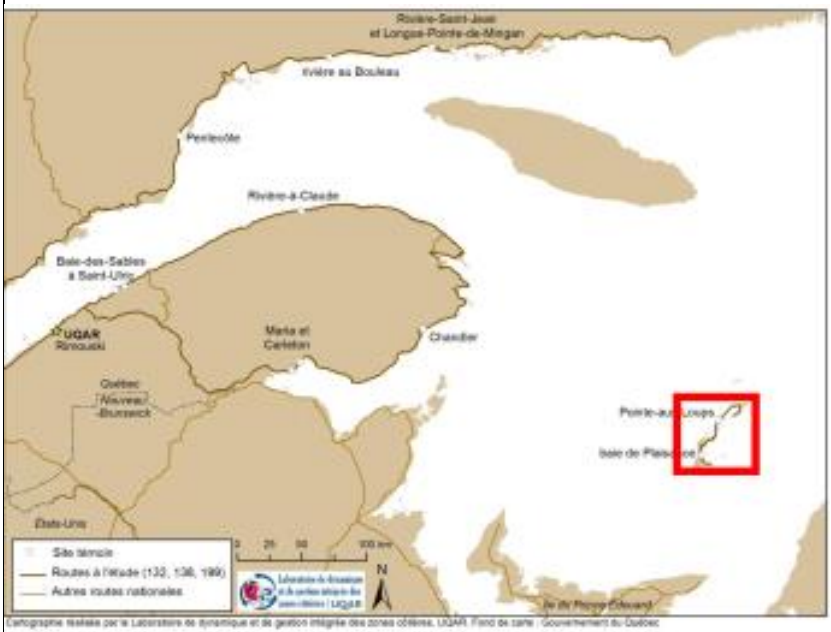
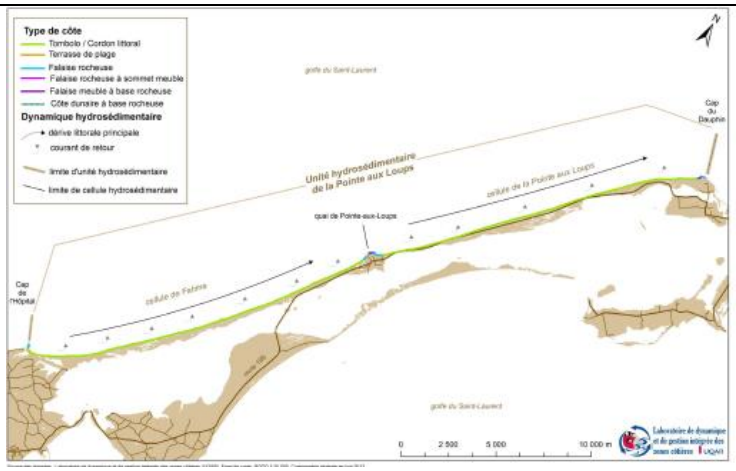
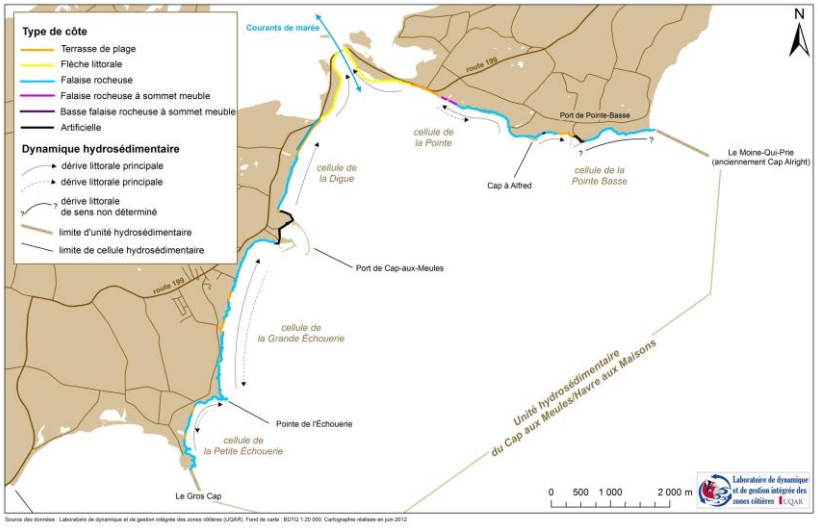


Figure 4: location of the Magdalen Islands.

	 Figure 2: Site #223, Cap aux Loup sector, Magdalen Island (QC). The third demonstration area of interest (site #334) is also located in Magdalen Island is the Cap aux Meules sector. The coast length of this sector is 18.67 km with multiple hydro-sedimentary units (artificial, movable cliffs and sand beaches).  Figure 3: Site#4, Cap aux Meules sector, Magdalen Island (QC).
Problems/issues:	<u>At site #1:</u> In the last years this sector has been extensively studied due to the proximity of the main road of the North Shore (Drejza et al. 2015). This road is the only access to the north of the Minganie Regional county municipality. The average historical erosion rate for the case site is -1.97 m/year between 1948 and 2005. Between 200-2017 mean annual rate = -1.39 m/y. This case study site includes two villagers namely Rivière-Saint-Jean (in the estuary of the eponymous river) and Longue-Pointe-de-Mingan. Route 138 is in this area the only link between communities, thus, a break in service would prevent any movement. The occupation of the territory is limited to a thin coastal fringe and in several sectors, the road is the only built infrastructure.

	At site #2: The coastal sector of the Manicouagan Peninsula - Upper North Shore, has for many years experienced major declines in its shoreline due to erosion and gravitational soil. All of this problem is widely documented in Dubois et al. (2005). These phenomena ultimately threaten the integrity of the properties that are implanted there, first at the level of land and then residences themselves. Public infrastructures are also threatened. On the Manicouagan Peninsula, erosion rates ranging from -0.1 to -3.6 m / year for about 70 years (Grondin et al., 1990; Bernatchez et Baker, 1995 ; Bernatchez, 1998, 2000, 2003a ; Dubois, 1999) ; For the last decade it erosion rate increase to -7 m/y on the sandy beach (Bernatchez, 2003a). <u>At Site #3 & #4:</u> Coastal erosion in Magdalen Island is a major issue for communities and public infrastructure. In a climate change context, less sea ice and more coastal submersion will increase the dynamics of erosion. Located in the centre of the Gulf of St. Lawrence, the Îles de la Madeleine is an archipelago of 10 islands (total area about 190 km_2) with a population of approximately 12 600. The living area of the archipelago is restricted, with the maximum width of rocky outcrops not exceeding 10 km and their central part often being high and steep. Tourism is a key component of the local economy. The Îles de la Madeleine are vulnerable to coastal hazards, and the archipelago is particularly sensitive to erosion. Coastal infrastructure on the Îles de la Madeleine is threatened by shoreline retreat at several sites, including the main road network of the archipelago and the sewage purification ponds of the main community In the Pointe aux Loup sector, erosion of the beach is impacting the road, the main access to the northern island of the archipelago. Historical migration rate is -0.70 m/year (1963 to 2008) and the expected rate to 2060 is -1.5 m/year. For Cap aux Meules sector the historical migration rate is -0.03 m/year (1963 to 2008) and the expected migration rate to 2060 is -0.26 m/year. The erosion in this sector will impact the local communities (1685 hab.) and numerous infrastructure such as the main harbour of the Island and the main road.
User organizations:	Ministry of Transport of Quebec (MTQ) [all sites] Ministry of public safety (MSP) [Site #3 & #4]
Available data:	<u>Site #1:</u> • Historical aerial photography (1949 (1:40000), 1976 (1:15000), 2005 (1:20000) and 2009 (ground resolution 0.10m)). • Ground Lidar survey: survey is done seasonally with a cloud of points each 0.20 m with a vertical mean error of 0.002 m and the horizontal mean error of 0.04 m.

	• Differential Global Positioning System (DGPS): DGPS measurement was acquired during the ground Lidar survey as ground point control for the Lidar Survey. • Aerial Lidar survey: aerial survey has been performed by the Ministry of Transport in 2008. With a horizontal accuracy of 0.25 m and vertical accuracy of 0.30 m • Measurement posts: Since 2000 the LDGIZC has paced 4 survey posts as ground sampling stations. Each year the distance between the post and the shore is measured using a millimetre surveying gallon with the accuracy of 10 cm. • Reconyx camera: Three numeric Reconyx camera has been installed in 2011. The image resolution is 3.1 MP and the acquisition time is every 15 minutes between 3h00 am to 21h00 pm EST. • Water levels and waves monitoring: waves and water currents are monitored using Acoustic Wave and Current meter (AWAC) with the accuracy of 0.01 m. Water levels and waves are also monitored using pressure sensor RBR deployed in the tidal zone. This extensive equipment allows the LDGIZC to characterize the littoral dynamics and identify the process of erosion. It has been used to develop models of erosion to assess infrastructure vulnerability to estimate the extend of the erosion impact. <u>Site #2 & #3:</u> • Historical aerial photography. • Ground Lidar survey: survey is done seasonally with a cloud of points each 0.20 m with a vertical mean error of 0.002 m and the horizontal mean error of 0.04 m. • Differential Global Positioning System (DGPS): DGPS measurement was acquired during the ground Lidar survey as ground point control for the Lidar Survey. • Measurement posts: survey posts are installed as ground sampling stations. Each year the distance between the post and the shore is measured using a millimeter surveying gallon with the accuracy of 10 cm. • Water levels and waves monitoring: waves and water currents are monitored using Acoustic Wave and Current meter (AWAC) with the accuracy of 0.01 m. Water levels and waves are also monitored using pressure sensor RBR deployed in the tidal zone.

Table 32. Product description GoQ #1: Near shore satellite derived bathymetry

Description of product no. 1	
General Description	
General service/product description:	Coastal managers have shifted their interest from coastline management (1D) to volume and space management (3D) over time (4D). This has created a demand on the surveyors to create seamless Topo-bathymorphology of the coastal zone to allow them assess close sediment balance. This product is a raster product containing a time stamped Digital Elevation Model of the coastal zone (including backshore, foreshore and nearshore).

	This product will be delivered as both a Digital Surface Model (DSM) and Digital Terrain Model (DTM). On most Canadian coastal charts, the surface of lower low water, large tide, or LLWLT, has been adopted as chart datum, but the term " lowest normal tide, " or " LNT, " has been retained on the charts since it encompasses a variety of other choices for chart datum on some older charts.
Uses and benefits:	The synoptic view of the remote sensing data would benefit to government of Quebec to assess the near-shore bathymetry change, and the dynamics of the bathy-morphology due to coastal erosion.
Product Specifications	
Spatial scale:	1:10,000
Minimum cell size: (or mapping unit)	A minimum cell size of 5 m is desirable.
Information layers:	The information products required are the bathymetric data from the coastal area of all the selected case study. The bathymetry would help understand the erosion dynamics of the sector. Timestamp; date of data collection of images used to create TBDEM Digital Surface Model; raster surface elevation model Digital Terrain Model; raster relief elevation (i.e. excluding structures and vegetation) Uncertainty in the elevation of DSM Uncertainty in the elevation of DTM
Product format:	Raster files in GeoTiff format
Software platform compatibility:	The products should be compatible with the platform SIGEC WEB Quantum GIS software.
Product accuracy:	+/-15cm RMSE (to allow comparison with LiDAR data)
Service Specifications	
Years of interest:	Interested in years since 1980s until present

Temporal range:	Change detection between 1980 to 2020
Updating frequency:	Every six-month change detection of the bathymetry.
Temporal baseline:	Year of reference to determine based on availability of in-situ data
Ordering:	Web based ordering system.
Delivery time required:	Annually for monitoring impact of erosion. Within a month for disaster impact on coastal ecosystems.
Delivery format:	Web-based
Validation data	
Available at the end-user's premises:	Measured of the coastline position and the shore distance from a survey post since 2003. Daily acquisition of camera imagery. • Historical aerial photography (1949 (1:40000), 1976 (1:15000), 2005 (1:20000) and 2009 (ground resolution 0.10m)). • Ground Lidar survey: survey is done seasonally with a cloud of points each 0.20 m with a vertical mean error of 0.002 m and the horizontal mean error of 0.04 m. • Differential Global Positioning System (DGPS): DGPS measurement was acquired during the ground Lidar survey as ground point control for the Lidar Survey. • Aerial Lidar survey: aerial survey has been performed by the Ministry of Transport in 2008. With a horizontal accuracy of 0.25 m and vertical accuracy of 0.30 m • Measurement posts: Since 2000 the LDGIZC has paced survey posts as ground sampling stations. Each year the distance between the post and the shore is measured using a millimetre surveying gallon with the accuracy of 10 cm. • Reconyx camera: Three numeric Reconyx camera has been installed in 2011. The image resolution is 3.1 MP and the acquisition time is every 15 minutes between 3h00 am to 21h00 pm EST. • Water levels and waves monitoring: waves and water currents are monitored using Acoustic Wave and Current meter (AWAC) with the accuracy of 0.01 m. Water levels and waves are also monitored using pressure sensor RBR deployed in the tidal zone.

Available elsewhere:	The product High Resolution Digital Elevation Model (HRDEM) is part of the CanElevation Series created in support to the National Elevation Strategy implemented by NRCan. It includes a Digital Terrain Model (DTM), a Digital Surface Model (DSM) and other derived data. In the southern part of the country (south of the productive forest line), DTM and DSM datasets are generated from airborne LiDAR data. They are offered at a 1 m or 2 m resolution and projected to the UTM NAD83 (CSRS) coordinate system and the corresponding zones. The datasets at a 1 m resolution cover an area of 10 km x 10 km while datasets at a 2 m resolution cover an area of 20 km by 20 km. In the northern part of the country (north of the productive forest line), due to the low density of vegetation and infrastructure, only DSM datasets are generated. Most of these datasets have optical imagery as their source data. They are generated at a 5 m resolution using the Polar Stereographic North coordinate system referenced to WGS84 horizontal datum or UTM NAD83 (CSRS) coordinate system. Each dataset covers an area of 50 km by 50 km: https://open.canada.ca/data/en/dataset/957782bf-847c-4644-a757-e383c0057995
Planned collection and when:	Yearly survey covering the all case study sites is planned.

Table 33. Product description GoQ #2: sediment volume changes

Description of product no. 2	
General Description	
General service/product description:	The coastal zone is that part of the land surface influenced by marine processes. Ocean waves, currents, tides, and storms are the major forces on the coast. The results of actions and interactions of these forces on the shoreline are called coastal processes: these include erosion and/or deposition of sediments. In particular, coastal erosion is the loss, long-term removal or displacement of land/sediment along the coastline leading to modification and/or retreat of the coastline landward. Under warming condition and longer ice-free period coastal erosion is a major source of sediment in the ocean. Recent studies suggest regional differences in the ratio between riverine and coastal erosion sediment input (Are 1998, Rachold et al., 2000).
Uses and benefits:	The synoptic view of the remote sensing data would benefit to government of Quebec to assess the sediment volume changes due to coastal erosion.
Spatial scale:	not applicable
Minimum cell size: (or mapping unit)	10m to 20m resolution

Information layers:	The information products required are the bathymetric data from the coastal area of all case study sites. Sediment volume changes will help understand the beach dynamics and predict impact of erosion and vulnerability of the infrastructure in place.
Product format:	Raster files in GeoTiff format or netcdf format
Software platform compatibility:	The products should be compatible Quantum GIS software
Product accuracy:	Sediments budget: +/- 5 m/years
Years of interest:	Time period: 2000 to 2020.
Temporal range:	Change detection between 2000 to 2020
Updating frequency:	Annually for monitoring impact of erosion. Within a month for disaster impact on coastal ecosystems. Within few days after storm surges for the disaster response impact.
Temporal baseline:	Year of reference to determine based on availability of in-situ data
Delivery time required:	Annually for monitoring impact of erosion. Within a month for disaster impact on coastal ecosystems.
Delivery format:	Web-based
Available at the end-user's premises:	Measured of the coastline position and the shore distance from a survey post since 2003. Daily acquisition of camera imagery. • Historical aerial photography (1949 (1:40000), 1976 (1:15000), 2005 (1:20000) and 2009 (ground resolution 0.10m)). • Ground Lidar survey: survey is done seasonally with a cloud of points each 0.20 m with a vertical mean error of 0.002 m and the horizontal mean error of 0.04 m.

	• Differential Global Positioning System (DGPS): DGPS measurement was acquired during the ground Lidar survey as ground point control for the Lidar Survey. • Aerial Lidar survey: aerial survey has been performed by the Ministry of Transport in 2008. With a horizontal accuracy of 0.25 m and vertical accuracy of 0.30 m • Measurement posts: Since 2000 the LDGIZC has paced survey posts as ground sampling stations. Each year the distance between the post and the shore is measured using a 111illimeter surveying gallon with the accuracy of 10 cm. • Reconyx camera: Three numeric Reconyx camera has been installed in 2011. The image resolution is 3.1 MP and the acquisition time is every 15 minutes between 3h00 am to 21h00 pm EST. • Water levels and waves monitoring: waves and water currents are monitored using Acoustic Wave and Current meter (AWAC) with the accuracy of 0.01 m. Water levels and waves are also monitored using pressure sensor RBR deployed in the tidal zone.
Available elsewhere:	Current and waves data are available on https://www.tides.gc.ca/eng/data. Provided by the department of fisheries and ocean of Canada.
Planned collection and when:	Yearly survey covering the all case study sites is planned.

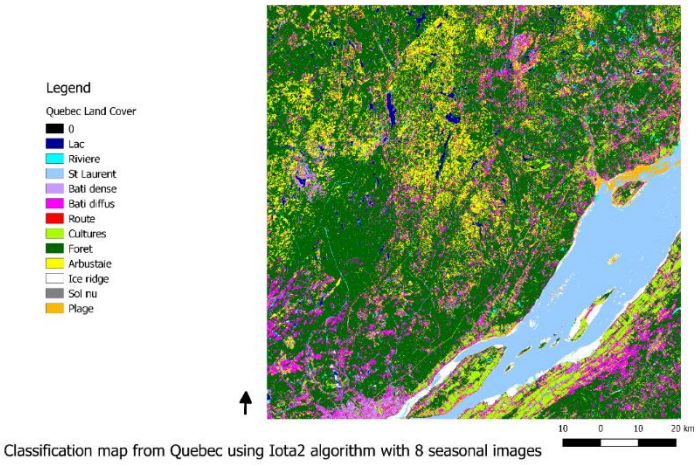
Table 34. Product description GoQ #3: Shoreline/Waterline delineation

Description of product no. 3	
General Description	**A tideline obtained by extracting a contour at different tidal elevations**
General service/product description:	Service and products from remote sensing expected are shoreline/waterline delineation. Beach level data (i.e. beach profiles, LiDAR surveys and RADAR flights) is being regularly and systematically collected along Saint-Lawrence coastline, from which the positions of contours representing datum elevations can be obtained. Datum-based tideline are therefore obtained from a Digital Elevation Model (DEM) of the coastal zone (backshore and foreshore) and an automatic contour extraction method. As end user we are interested on both, the datum-based contour and DEM derived from satellite imagery. On most Canadian coastal charts the surface of lower low water, large tide, or LLWLT , has been adopted as chart datum, but the term " lowest normal tide, " or " LNT, " has been retained on the charts since it encompasses a variety of other choices for chart datum on some older charts.
Uses and benefits:	The synoptic view of the remote sensing data would benefit to government of Quebec to assess the dynamics of the coastal erosion and the changes of the shoreline. Tidelines is used as an indicator of standard of protection. Will allow coastal engineering practitioner and research community to

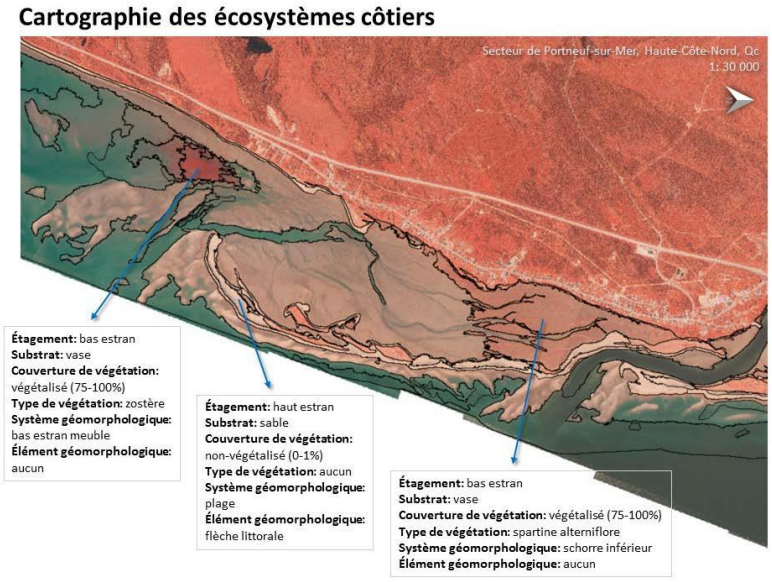
	better understand process of change and validate conceptual and numerical models used to assess coastal change and adaptation options.
Spatial scale:	1:10,000
Minimum cell size: (or mapping unit)	5m (Sentinel 1) to 10 m (Sentinel 2) resolution
Information layers:	The information products required are the shoreline/waterline of all case study sites. Delineation of waterline allows to assess the changes due to beach dynamics. Tidelines; vector lines for different tide elevations (LLWLT) Digital Elevation Model; used to extract the different tide contours Error lines; Lines that have errors (for instance not closed rings or self-intersections) Date and time; of the image used to delineate the tideline Uncertainty in the elevation of the tide level Uncertainty in the elevation due to waves and atmospheric processes Uncertainty in the elevation of the DEM Uncertainty in the horizontal location of the tideline associated to uncertainty on vertical elevations
Product format:	Vector and Raster formats; Vector for the tidelines: Raster for the DEM: ASCII, TIFF & GeoTIFF uncompressed and compressed (LZW, ZIP)
Software platform compatibility:	The products should be compatible Quantum GIS software
Product accuracy:	Coastline/Waterline : +/- 10 m accuracy
Years of interest:	Time period : 1999 to 2020.
Temporal range:	Change detection between 2000 to 2020

Updating frequency:	Seasonally change of the shoreline/waterline
Temporal baseline:	Year of reference to determine based on availability of in-situ data
Delivery time required:	Annually for monitoring impact of erosion. Within a month for disaster impact on coastal ecosystems.
Delivery format:	Web-based
Available at the end-user's premises:	Measured of the coastline position and the shore distance from a survey post since 2003. Daily acquisition of camera imagery. • Historical aerial photography (1949 (1:40000), 1976 (1:15000),2005 (1:20000) and 2009 (ground resolution 0.10m)). • Ground Lidar survey: survey is done seasonally with a cloud of points each 0.20 m with a vertical mean error of 0.002 m and the horizontal mean error of 0.04 m. • Differential Global Positioning System (DGPS): DGPS measurement was acquired during the ground Lidar survey as ground point control for the Lidar Survey. • Aerial Lidar survey: aerial survey has been performed by the Ministry of Transport in 2008. With a horizontal accuracy of 0.25 m and vertical accuracy of 0.30 m • Measurement posts: Since 2000 the LDGIZC has paced survey posts as ground sampling stations. Each year the distance between the post and the shore is measured using a millimetre surveying gallon with the accuracy of 10 cm. • Reconyx camera: Three numeric Reconyx camera has been installed in 2011. The image resolution is 3.1 MP and the acquisition time is every 15 minutes between 3h00 am to 21h00 pm EST. • Water levels and waves monitoring: waves and water currents are monitored using Acoustic Wave and Current meter (AWAC) with the accuracy of 0.01 m. Water levels and waves are also monitored using pressure sensor RBR deployed in the tidal zone.
Available elsewhere:	N/A
Planned collection and when:	Yearly survey covering the all case study sites is planned.

Table 35. Product description GoQ #4: Land use Land-Cover and habitat maps

Description of product no. 4	
General Description	
General service/product description:	Land use landcover and habitat maps This product is a vector polygon product containing a time stamped Habitat map of the coastal zone (including backshore (first few meters of the backshore), foreshore and nearshore). This habitat map is a remotely sensed product which classify site relevant habitats visible at the time of satellite capture. The classification uses supervised classification techniques; these are techniques which are trained using ground data.  Classification map from Quebec using Iota2 algorithm with 8 seasonal images Classification map from Quebec using sentinel 2 data.
Uses and benefits:	Remote sensing data would benefit to government of Quebec to assess the backshore land use-land cover changes due to coastal erosion. Last land cover and habitat maps published covered the period between 1999 to 2005.
Spatial scale:	1:10000
Minimum cell size: (or mapping unit)	5m to 10 m ground resolution
Information layers:	The information about LandUse/LandCover (LU/LC) will be useful to assess the changes or loss of usable land on the backshore environment. High priority should be to assess the change on (1) Beach (2) Ice ridge (3) Dense artificial surface and associated areas, (4) Diffuse artificial surface and associated areas, (5) Road (6) Cultivated and Managed Terrestrial Areas Lower priority : (7) Forest

	(8) Water bodies
Product format:	o Vector format in shapefile format for the additional information layers;
Software platform compatibility:	The products should be compatible Quantum GIS software
Product accuracy:	LULC: +/- 10 m accuracy Quantitative accuracy assessment carried out on them in the form of a confusion matrix using ground data set aside and not used in training the classifier. With a minimum accuracy of 90% for classes identification.
Years of interest:	Time period: 1999 to 2020.

Temporal range:	Change detection between 2000 to 2020
Updating frequency:	Seasonally change detection of the land use and landcover maps
Temporal baseline:	N/A.
Delivery time required:	Annually for monitoring impact of erosion. Within a month for disaster impact on coastal ecosystems.
Delivery format:	Web-based
Available at the end-user's premises:	Coastal habitat of the shore of St-Lawrence was digitized using very high resolution aerial photography acquisition.  Example of coastal ecosystems mapping (preliminary) being generated as part of the Coastal Resilience project by the Research Chair in Coastal Geoscience at UQAR
Available elsewhere:	Land cover maps are produced by the natural resource Canada department. Contained within the Atlas of Canada's Various Map Series, 1965 to 2006, is map which shows the distribution of land cover types across Canada. The images are Advanced Very High Resolution Radiometer data, which means very precise detail, is shown on the map. The land cover map contains 31 land cover classes: 12 forest; 3 shrub land; 6 barren land and grassland; 7 developed land types including cropland; mosaic and built-up areas; and 2 non vegetable land cover types. Base data is limited to a small selection to populated places and major roads. Descriptions for each of the 31 land cover classes are available. The imagery data are from 1995. ○ https://open.canada.ca/data/en/dataset/c585dec3-8153-5da2-838a-18820fe7a912 Map of North American land cover at a spatial resolution of 30 meters provides a harmonized view of the physical cover of Earth's surface across the continent based on 2010 Landsat satellite imagery. Nineteen Level II land cover classes were defined using the Land Cover Classification

	System (LCCS) standard developed by the Food and Agriculture Organization (FAO) of United Nations. o http://www.cec.org/sites/default/atlas/map/
Planned collection and when:	Yearly survey covering the all case study sites is planned.

Glossary

Coastal Erosion: Coastal erosion is the process of wearing away material from the coastal zone due to imbalance in the supply and export of material from a certain section. It takes place in the form of scouring in the foot of the cliffs or in the foot of the dunes. Coast erosion takes place mainly during strong winds, high waves and high tides and storm surge conditions, and results in coastline retreat (back-wearing) and or lowering of the bottom elevation (down-wearing). The rate of erosion is correctly expressed in volume/length/time, e.g. in $m^3/m/year$, but erosion rate is often used synonymously with coastline retreat, and thus expressed in m/year.

Coastal Flooding: occurs when normally dry, low-lying land is flooded by seawater. The extent of coastal flooding is a function of the elevation inland flood waters penetrate which is controlled by the topography of the coastal land exposed to flooding. The seawater can flood the land via from several different paths: (1) Direct flooding — where the sea height exceeds the elevation of the land, often where waves have not built up a natural barrier such as a dune system; (2) Overtopping of a barrier — the barrier may be natural or human engineered and overtopping occurs due to swell conditions during storm or high tides often on open stretches of the coast. The height of the waves exceeds the height of the barrier and water flows over the top of the barrier to flood the land behind it. Overtopping can result in high velocity flows that can erode significant amounts of the land surface which can undermine defence structures; (3) Breaching of a barrier — again the barrier may be natural (sand dune) or human engineered (sea wall), and breaching occurs on open coasts exposed to large waves. Breaching is where the barrier is broken down or destroyed by waves allowing the seawater to extend inland and flood the areas. Coastal flooding is largely a natural event, however human influence on the coastal environment can exacerbate coastal flooding. Extraction of water from groundwater reservoirs in the coastal zone can enhance subsidence of the land increasing the risk of flooding. Engineered protection structures along the coast such as sea walls alter the natural processes of the beach, often leading to erosion on adjacent stretches of the coast which also increases the risk of flooding.

Coastal State Indicators (CSI): are a reduced set of measurable parameters that can simply, adequately and quantitatively describe the dynamic-state and evolutionary trends of coastal systems [6].

Coastal Risk Management (CRM): It is taking a risk-based approach to managing the threat of coastal flooding and coastal erosion.

Coastal Zone (CZ): is the whole region from the 200 m bathymetric contour at sea to the 200 m elevation contour on the land, as defined by the Land Ocean Interactions in the Coastal Zone (LOICZ) programme of the International Geosphere Biosphere Programme (Turner, R.K. and Adger, W.N., 1996. Coastal zone resources assessment guidelines. LOICZ Reports & Studies, No. 4. Texel, The Netherlands, Land–Ocean Interactions in the Coastal Zone Programme: 101.).

Datum-based shoreline indicator: is a shoreline indicator determined by the intersection of the coastal profile with a specific vertical elevation, defined by the tidal constituents of a particular area, for example, mean high water (MHW) or mean sea level [2].

Integrated Coastal Management: Integrated Coastal Zone Management (ICZM) is a resource management system following an integrative, holistic approach and an interactive planning process in addressing the complex management issues in the coastal area [1].This concept was borne in 1992 during the Earth Summit of Rio de Janeiro. The policy regarding ICZM is set out in the proceedings of the summit within Agenda 21, Chapter 17. The European Commission defines ICZM as “a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. It covers the full cycle of information collection, planning (in its broadest sense), decision making, management and monitoring of implementation. ICZM uses the informed participation and cooperation of all stakeholders to assess the societal goals in a given coastal area,

and to take actions towards meeting these objectives. ICZM seeks, over the long-term, to balance environmental, economic, social, cultural and recreational objectives, all within the limits set by natural dynamics. 'Integrated' in ICZM refers to the integration of objectives and also to the integration of the many instruments needed to meet these objectives. It means integration of all relevant policy areas, sectors, and levels of administration. It means integration of the terrestrial and marine components of the target territory, in both time and space"[2].

Proxy-based shoreline indicator: is a shoreline indicator based on a visually or non-visually discernible coastal feature. An example of visually discernible indicator is a feature that can be physically seen, for example, a previous high-tide line or the wet/dry boundary. An example of a non-visually discernible coastal feature is the zone of high-pixel brightness variance only detectable when applying image processing techniques to extract proxy shoreline features from digital coastal images that are not necessarily visible to the human eye.

Shoreline Indicator (SI): A shoreline indicator is a feature that is used as a proxy to represent the 'true' shoreline position. [2] reviewed shoreline definition and detection techniques, and carried out a comprehensive literature study. They categorized shoreline indicators in three groups: visible discernible features, tidal datum-based indicators and indicators based on the processing technique to extract the shoreline.

Wetland restoration: is the manipulation of a former or degraded wetland's physical, chemical, or biological characteristics to return its natural functions. Wetland restoration often involves the artificial breaching of an existent defence allowing the sea water to flood the low lying land behind.

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: https://envirolib.apps.nerc.ac.uk/olibcgi.

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