BGS DIGITAL

User guide: BGS GeoCoast

Open report OR/21/001

British Geological Survey

BRITISH GEOLOGICAL SURVEY

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BRITISH GEOLOGICAL SURVEY

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We publish an annual catalogue of our maps and other publications; this catalogue is available online or from any of the BGS shops.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as basic research projects. It also undertakes programmes of technical aid in geology in developing countries.

The British Geological Survey is a component body of UK Research and Innovation.

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Foreword

The British Geological Survey (BGS) is a world-leading geological survey, focusing on public-good science for government, and research to understand earth and environmental processes.

We are 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

We provide expert services and impartial advice in all areas of geoscience. As a public sector organisation, we are responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. Our client base is drawn from the public and private sectors both in the UK and internationally.

The BGS is a component body of the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI).

DATA PRODUCTS

The BGS produces a wide range of data products that align to government policy and stakeholder needs. These include baseline geological data, engineering properties and geohazards datasets. These products are developed using in-house scientific and digital expertise, and are based on the outputs of our research programmes and substantial national data holdings.

Our products are supported by stakeholder focus groups, identification of gaps in current knowledge and policy assessments. They help to improve understanding and communication of the impact of geo-environmental properties and hazards in Great Britain, thereby improving society's resilience and enabling people, businesses, and the government to make better-informed decisions.

Acknowledgements

This report is the published product of a study by the British Geological Survey (BGS) to produce a digital datasets depicting the range of geoproperties and processes prevalent around the coastline of Great Britain. The methods used to derive the data were determined by team of specialists with a broad range of expertise from satellite analysis, engineering geology to landform analysts and statistical modellers. The team includes the following BGS staff (in alphabetical order):

Luke Bateson, Andy Barkwith, Gareth Carter, Clive Cartwright, Deborah Daley, Claire Dashwood, Jeremy Everest, Antonio Ferreira, Katy Freeborough, Henry Holbrook, Carl Horabin, Andrew Hulbert, Ekbal Hussain, Lee Jones, Jonathan Lee, Katy Lee (project leader), Katy Mee, Alessandro Novellino, Andres Payo, Jenny Richardson, Sophie Taylor, Rowan Vernon, Chris Williams.

Many individuals in BGS have contributed to the project. This assistance has been received at all stages of the study. In addition to the collection of data, many individuals have freely given their advice, and provided expert knowledge. Of the many individuals who have contributed to the project we would particularly like to thank the following: Keith Westhead, Mark Barron, Hannah Jordan (previous BGS employees), Ricky Terrington, Gareth Jenkins (contributory research) and Joshua McIntyre, Adam Nudds and Bradley Booth (Student placements). We would also like to thank the BGS data checking team and Andres Payo and Russell Lawley for their comprehensive science review.

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Summary

Developed by the British Geological Survey (BGS), the GeoCoast data product informs users and stakeholders about a broad range of geoproperties and processes around the coast of Great Britain.

GeoCoast is an integrated GIS package of datasets designed to inform and support coastal management, planning and adaptation to coastal flooding and coastal erosion.

GeoCoast includes information on the morphology, behaviour and vulnerability of the coastline, underpinned by its geology and its coastal context (shape, orientation, tidal range, etc.).

GeoCoast can be used to underpin coastal decision making and planning relative to coastal inundation, erosion and climate change impacts. The datasets are compatible with Shoreline Management Plan areas. It is targeted at coastal practitioners including regulatory bodies, Local Authorities, and asset owners.

The datasets are divided into two data packages: GeoCoast Premium (a suite of detailed baseline datasets), and GeoCoast Open (a suite of open datasets, including a coastal multi-faceted domain analyses).

The purpose of this user guide is to basic provide information about these datasets, the nature and diversity of geo-properties around the GB coast and to act as a quick-start guide to using and understanding this BGS GeoCoast data product.

1 Introduction

1.1 THE BGS GEOCOAST DATA PRODUCT

BGS GeoCoast is an integrated GIS package of datasets designed to inform and support coastal management, planning and adaptation to coastal flooding and coastal erosion around the coast of Great Britain (GB; except Orkney and Shetland). It is based on the outputs of numerous research programmes, stakeholder advice and data analytics to provide data sufficient for users to analyse and assess a range of coastal risks.

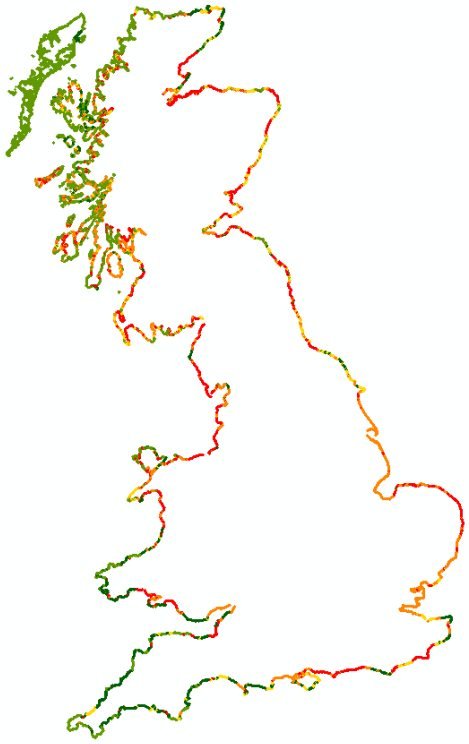

Figure 1: Great Britain coverage of the GeoCoast data product (please note that V1 of this dataset excludes the islands of Shetland and Orkney)

1.2 WHAT DOES GEOCOAST INCLUDE

The GeoCoast data product provides information on the morphology, behaviour and vulnerability of the coastline, underpinned by its geology and coastal context (shape, profile, etc.). The datasets are divided into two data packages: GeoCoast Premium (essential baseline datasets), and GeoCoast Open datasets, (including a multi-faceted domain analyses) which include the following information:

GeoCoast Premium: Baseline Data

- Foreshore (type, properties, spatial area).
- Backshore (type, properties, spatial area).
- Coastal erosion susceptibility (vertical cliff layers, properties).
- Cliff profiling (slope angle, distance, cliff height).
- Inundation under climate change scenarios (future sea level rise forecast for 2050, 2080, 2100).
- Groundwater flooding & coastal flood (combined hazards indicating exacerbated impact).
- Coastal subsidence potential (satellite measurements and lithology type).

GeoCoast Open: Open Data

- Historic records (coastal photographs, diagrams and logs from BGS archives, memoirs, sheet explanations, Regional Guides and maps.
- Lines of cross section (geological).
- Regional statistics (Local Authority and Shoreline Management Plan regions/areas attributed summary statistics from the baseline GeoCoast datasets, e.g. % length of coastline of high susceptibility to erosion).

GeoCoast Open: Coastal Domains

- A coastal domain is a segment of coastline that possesses a character defined by the sum of its basic morphological characteristics (e.g. platform, barrier, estuary) and geological properties and behavior (e.g. weak strata, resilient strata, structure).
- Analysis of key variables and combinations of data available within the BGS GeoCoast product, including lithology, cliff strength, backshore buffer and geomorphology.
- Provides a benchmark for describing the coastline and coastal change which is not bound by administrative districts.
- Total of 11 profile domains and 10 erosion domains are defined.

1.3 WHAT IS GEOCOAST USED FOR

GeoCoast can be used to underpin coastal decision making and planning relative to coastal inundation, erosion and climate change impacts; the datasets have been designed to be compatible with Shoreline Management Plan areas. It is targeted at coastal practitioners including regulatory bodies, Local Authorities, asset owners. The datasets can be used for a range of assessments from regional overviews and comparisons, through to incorporation into more local coastal vulnerability assessments.

1.4 WHY WAS GEOCOAST DEVELOPED

Recognising, recording and measuring coastal processes and hazards are becoming increasingly important, especially with respect to current and predicted climatic changes. Coastal erosion and flooding pose a significant threat to people living and working in coastal environments, as well as the associated threats to infrastructure and assets. Recent storms, including Storm Callum in 2018, Storm Frank in 2014 and the east coast tidal surge in 2013, (BBC 2013, 2014, 2018) have caused widespread flooding, damage to properties and infrastructure, power outages and travel disruption. Repairs to homes, buildings, infrastructure and coastal defences following these storm events cost tens of millions of pounds and took several months to complete causing disruption to life, livelihoods and the national economy, with impacts continuing long after the events. These events have nevertheless served to highlight the vulnerability of the coastline and related risks. The importance of coastal resilience and adaptation forms a major part of DEFRA's 25 Year Environment Plan, which aligns with the on-going developments relating to the UK Government's Environment Bill. In addition, recent reports such as: the special report from the IPCC (The Intergovernmental Panel on Climate Change) highlighting the human causes of the now almost inevitable 1.5°C rise in global temperatures above pre-industrial levels, and calling for a strengthening of the global response to climate change; the Environment Agency's National flood and coastal erosion risk management strategy for England, which sets out a vision of a nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100; and recent discussions around COP26 in Glasgow (November 2021).

Internationally, several countries have developed coastal vulnerability indexes. For example, the USGS's vulnerability to sea level rise was developed in 1999 to assess accelerated sea level rise, whilst Canada (https://dfo-mpo.gc.ca/science/rp-pr/accasp-psaccma/projects-projets/004-eng.html) and New Zealand (https://data-niwa.opendata.arcgis.com/datasets/c894b53b102f4f9db55278f7572ca4f6/explore) also have similar projects and online resources. Within Europe coastal vulnerability tools have been

reviewed by many, for example Climate ADAPT is a European partnership providing support in adapting to climate change, including a coastal vulnerability index technical paper (Ramieri, et al.).

As well as government-funded initiatives, there are abundant academic-hosted resources designed for use across multiple countries and continents. For example, the InVEST coastal vulnerability model uses geophysical and natural habitat characteristics of coastal landscapes to compare their exposure to erosion and flooding in severe weather. It is an open-source suite of models to map ecosystem services. Multiple other examples have been documented in the literature (e.g. Fitton, et al., 2016, Bevacqua, et al., 2018, Cogswell, et al., 2018).

Previous studies of our coastline include Future Coast (future coastal evolution study 2000-2002, DEFRA) and the more recent Scottish Government funded 'Dynamic Coast' (https://www.dynamiccoast.com/). Both projects characterise the coast in terms of past coastal behaviour and provide projected erosion potential and potential impact on society. The Environment Agency (EA) published their first 'National Coastal Erosion Risk Mapping (NCERM)' in 2019, which provides statistically modelled erosion rates for England and (parts of) Wales based on historic events.

Most of these projects and programmes draw upon a common set of environmental variables which include coastal morphology, coastal slope, sea level change, measured shoreline erosion/accretion, wave height and tidal range. Detailed sensor datasets (e.g. Bathymetry surveys, wave data, LIDAR, etc.) are also now widely available and it has become easier to develop models that can leverage this new data more efficiently. However, few schemes incorporate geological properties and processes (such as rock strength) in a nationally consistent output. For example, NCERM states that "Details of geologically complex areas, known as "complex cliffs" are, in general, not included within the dataset due to the inherent uncertainties associated with predicting the timing and extent of erosion at these locations". Consequently, the potential impact and influence that these geological factors generate, especially at a more granular scale is not represented. GeoCoast plugs this data-gap and provides a suite of geological properties data that can be used by stakeholders as key components within a modelling environment.

1.5 HOW TO USE THIS USER GUIDE

The purpose of this user guide is to provide a quick start guide to using the GeoCoast datasets. A brief overview of the methodology and source datasets used is provided (chapter 3) for understanding the components and data development process. Chapter 4 then details the specific content for each dataset, explaining the attributes and formats. We also provide a case study example to briefly describe how the datasets might be used (chapter 2).

Limitations and notes about accuracy of the data are described in chapter 6 however some key points to note include:

- The data product is based on the natural geological properties and doesn't take into account artificial features such as coastal defences.
- All data are hung off the OS open high-water polyline for a consistent GB-wide baseline. This means that the cliff or coastal slope properties will be attribute to this rather than the exact top or base of the cliff and the attributes are still correct for that portion of coast.
- Selected visualisation (layer) files have been provided to help display the data but other attributes are available. Multiple layer files can be based on a single data shapefile, the layer files simply highlight one of the attributes.
- Inherent gaps or changes in geology code will be evident in some places as a result of the source datasets used (both BGS and external datasets).

This user guide is not intended as a full method review and peer review research document, where appropriate, BGS will publish its scientific research in peer reviewed journals, however appropriate references are provided.

2 Case Study

This chapter provides a specific case study example to describe a set of issues and challenges relevant to stakeholders and explain how the datasets could potentially be used in such a situation. In this section we focus on the coastal erosion at Happisburgh on the Norfolk coast and also link to a series of additional case studies provided online as ESRI StoryMaps.

2.1 HAPPISBURGH, NORFOLK

2.1.1 The Problem

The primary coastal problem is understanding what aspects of the shoreline are influencing failure or resilience and where the shoreline requires more or less intervention. This also includes the potential issue of 'coastal catch-up', which is how a coastline responds to the removal of a coastal defence(s).

Happisburgh provides an excellent case study for 'coastal catch-up' and specifically, the issue of when coastal catch-up will slow down as a new equilibrium is reached and whether this type of coastal feedback process will impact coastlines with similar defence strategies around the UK.

Happisburgh is a small coastal village on the North Norfolk coast, faced with an eroding coastline. A local Coastal Concern Action Group (CCAG) was formed in 1999 to lobby central and local government for funding because the coastal defences, which once effectively mitigated coastal erosion, but are now in a state of disrepair due to a change in coastal management policy. Successive storm events (as well as the more frequent wave action during high tides) have repeatedly caused erosion of the weak cliffs beneath the village. In December 2013 a storm surge caused the final remaining property at the seaward end of Beach Road to be badly undermined, requiring it to be demolished.

Figure 2: Cliff erosion evident at Happisburgh, Norfolk

2.1.2 The Challenge

The construction of coastal defences in north Norfolk, many of which were installed in response to the 1953 North Sea floods, have generally acted to reduce coastal erosion by limiting lateral sediment transport (longshore drift) and enabling (locally) build-up of the beach wedge. However, the local trapping of sediment and build-up of the beach wedge has also resulted in a reduction of sediment supply to down-drift beaches. In places, this has caused down-drift beach starvation and the reduction of beach profiles leading to enhanced cliff erosion. The effectiveness of coastal defences is well illustrated at Happisburgh where wooden breakwaters and groynes installed during the 1950s initially caused a dramatic reduction in cliff erosion. However, by the late 1980s these had fallen into a state of disrepair. In 1991, 300 m of defences were removed to the south of Happisburgh due to storm damage and this has resulted in a dramatic increase in coastal erosion. Between 1994 and 2010 the cliff line to the south of the village has receded by up to 150 m. Much of the sediment derived from the cliffs at Happisburgh has been trapped further to the south at Sea Palling (4-6 km away) where a series

of shore-parallel reef-style breakwaters were constructed during the late 1990s to protect exist coastal defences designed to prevent inland coastal flooding. The trapping of sediment derived from Happisburgh at Sea Palling, has resulted in down-drift starvations to several low-lying coastal areas to the south (e.g. Winterton-on-Sea and Hemsby) which have subjected to accelerated coastal erosion.

2.1.3 How GeoCoast can be used?

The GeoCoast data product provides information on the type of coast, its morphology, geology and properties. This data can be used to help identify zones of future weakness, potential erosion and target mitigation or adaptation requirements. The GeoCoast Open datasets can be used as a starting point to create an overview of characteristics and coastal types, followed by a more detailed assessment using the GeoCoast Premium 50 m gridded datasets.

The GeoCoast Open datasets provide an overview of the coastal features relating to both county (administrative area) and SMP unit, to assess the potential threat of erosion or inundation (GeoCoast statistics). For example, Norfolk has an estimated 36% (59.6 km) of its coastline at threat of inundation by 2050, increasing to 37.9% (and c. 62 km of coast) by 2080 and 39.1% (64.2 km) by 2100. Comparatively, Suffolk has an estimated 19.5% (15.4 km) of coast under threat of inundation by 2050, increasing to 21.5% (17 km) by 2080 and 23.5% (18.6 km) by 2100. Other statistics available include percentage of the coastline classed as high erosion susceptibility, length of rail/road and urban areas under threat of inundation. The historic data contains scans of local images that could be used to determine historic coastal changes. For Happisburgh a data point links through to the British Regional Guide (and image UID174).

Alongside this, the GeoCoast domains identifies areas of similar coastline taking into account the erosion susceptibility, coastal profile, and backshore width. The coastline at Happisburgh is classed as an erosion domain G and profile domain 1. Other sites along England's coast, which have been classed in the same coastal domain include parts of the coast around Skipsea in Yorkshire, which consist of relatively low (<10 m) cliffs composed of soft glacial deposits, north of Southwold in Suffolk, around Lepe on the Solent east of the Beaulieu River in Hampshire and parts of the coast south of Frinton-on-sea in Essex (protected by sea defences). Not all areas will have defences and have differing management plans, however it is useful to consider that if defences are removed from areas of similar characteristics, might the coastal processes behave as Happisburgh and can lessons be learned/shared.

The GeoCoast Premium datasets identify more detailed parameters at a 50 m scale. The GeoCoast erosion susceptibility rates this part of the Norfolk coastline as moderate to high susceptibility with some lithologies within the cliff rated as high susceptibility. At Happisburgh, the cliffs (less than 10 m high) consist of weak glacial sequences comprising tills (stony clay), laminated clays and sands. Cliff instability occurs due to topples and debris flows within the glacial sands, often exacerbated by periods of prolonged rainfall. Instability also occurs due to direct erosion by waves. To the south of the current beach access, the basal till often forms a wave-cut platform with direct wave-erosion of the overlying glacial clays and sands.

Taking a specific example from the GeoCoast erosion susceptibility dataset (e.g. cell 369660, Table 1 below) the attribution east of Happisburgh lighthouse identifies the locality to consist of: Lithology 1: HPGL-DMTN, Happisburgh Glacigenic Formation (till), overlain by lithology 2: HPGL-S, Happisburgh Glacigenic Formation (sand), overlain by lithology 3: LOFT-DMTN Lowestoft Formation (till). Lithology 1 and 2 are subjected to continual wave attack during high tides, whereas lithology 3 is subjected to wave attacks primarily during storm events or if the beach level is periodically higher. Lithology 3 is also vulnerable to landsliding due to elevated pore pressures (groundwater infiltration) building up at the basal lithology boundary.

Table 1: Example attributes near Happisburgh lighthouse

Field	Attribute	Erosion class
FID	369660	
Lithology1	HPGL-DMTN	
Lith1_Scr	43.2	Moderate-High

Lithology2	HPGL-S	
Lith2_Scr	80	High
Lithology3	LOFT-DMTN	
Lith3_Scr	46.6	Moderate-High

Inundation and flooding are not an issue at this specific location; however, other low-lying coastal areas could be at risk and sites such as Sea Palling south of Happisburgh is protected by sea defences and further afield, sites such as Tillingham Marshes could experience coastal inundation under climate change by 2050.

For further case study examples, a series of ESRI StoryMaps are available at:

Belhaven Bay, Boscastle, Happisburgh, Port Mulgrave, Dungeness, Tillingham Marshes, Bacton & Walcott

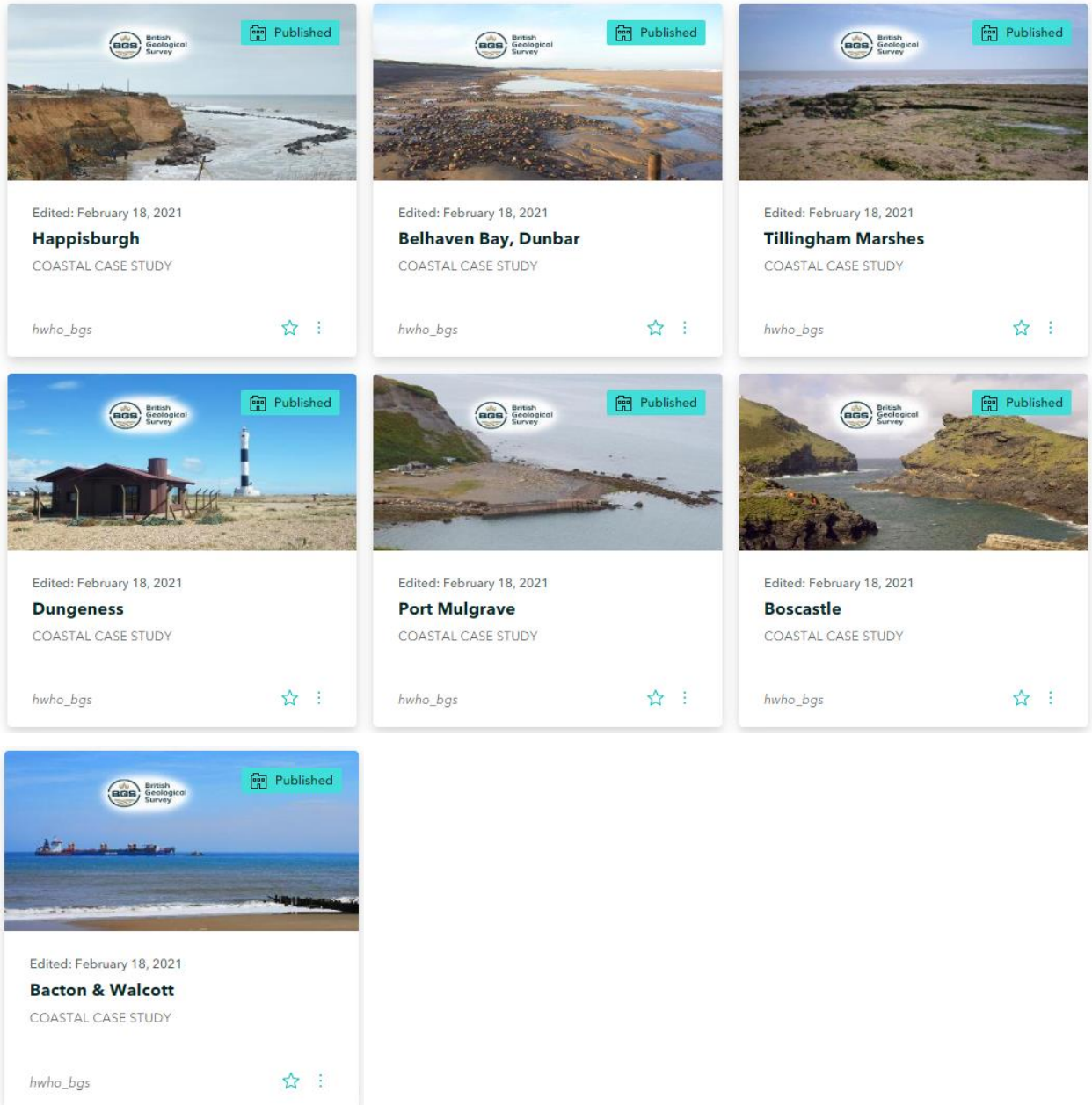

Figure 3: A selection of case studies are available in StoryMap formats

3 Methodology

3.1 OVERVIEW

The methodology for creating the GeoCoast data product consists of the summary analysis and reprocessing of a suite of baseline datasets that are provided as a spatial dataset comprised of 50 m by 50 m cellular grids (vector). The final gridded output is designed to streamline the multiple key datasets and potential factors that impact on coastal processes. Rather than having multiple layers, the data will be combined to create an easy-to-use dataset that contains all of the relevant data necessary for a coastal assessment. The gridded format (50 m grid cells) also helps to convey to users the accuracy limitations of the data rather than having a specific vector line that users often perceive as a precise location, particularly where shorelines are concerned. These include the following information:

GeoCoast Premium: Coastal Properties Grid

- Foreshore (type, properties, spatial area): the area between high water line and low water line.
- Backshore (type, properties, spatial area): the area between high water line and the landward limit of coastal deposits.
- Coastal erosion susceptibility (vertical cliff layers, properties): erosion scores ranking from 0 (low susceptibility to erosion) – 100 (high susceptibility to erosion) and divided into 5 susceptibility classes. Data available for every lithology within in cliff section plus summary data for mean, worst-case and lithology 1 (base lithology).
- Cliff profiling (slope angle/distance/cliff height): based from high water line to top of cliff section as defined by transects across a Digital Terrain Model (DTM).
- Inundation under climate change scenarios (future sea level rise, 2020 (baseline), 2050, 2080, 2100): max flood extents as defined by UKCP18 sea level rise climate scenarios.
- Coastal subsidence potential (satellite measurements and lithology type): based on geology properties and measured subsidence from satellite.
- Groundwater flooding zones: A combined assessment of coastal inundation (not including UKCP18 scenarios) and groundwater flooding susceptibility to identify areas where combined hazards have the potential to exacerbate impact.

In addition to the gridded datasets, we also provide the following data:

Open data

- The analysis of the baseline datasets (above) to provide a range of summary statistics aligned to commonly used boundaries i.e. SMPs, Counties and Local Unitary Authorities.
- The compilation of coastal relevant figures and photographs from BGS archives and publications.

Coastal Domains

- The analysis of a range of parameters and combinations of data to identify key characteristics of different types of coast.
- Provided on the same 50 m x 50 m vector grid.

3.2 DATASET METHODOLOGY DETAILS

3.2.1 Foreshore

The foreshore dataset contains the spatial extent of coastal geomorphological features including beaches, tidal flat deposits, saltmarshes, wave-cut platforms or any combination of these that would potentially act to dissipate wave energy before it meets the cliff or backshore. These features effectively “buffer” the cliff or backshore from wave energy, potentially decreasing rates of erosion. Expert geologists used a range of tools, such as OS Open Data, published geological maps and aerial imagery, to characterise the foreshore into beach, tidal flat, wave-cut

platform or saltmarsh, or any combination of these. This data was then transferred onto the 50 m grid using the extent between high-water line and low-water line.

3.2.2 Backshore

The ability to identify a landward limit of 'coastal' deposits is a useful factor in determining the extent of the coastal plain both in terms of spatial variation/extent and composition/lithology. Previous research has identified the landward limit of flood deposits (from the coast). To classify and characterise the Backshore Zone of the GB coast, we define the 'backshore' as the zone between the high-water line and the landward limit of coastal deposits. The LEX_RCS lithologies were identified and additional data derived from the BGS Geology WMS was extracted to create the GeoCoast backshore attributes, including information on the geological setting.

3.2.3 Erosion susceptibility

The erosion susceptibility assessment considers a number of geological engineering properties of cliff sections (and low-lying deposits) around the GB coastline. The analysis uses the BGS Civils discontinuities and strength datasets and the BGS Permeability dataset. A programme of work was undertaken in 2015 by a group of experienced geologists to accurately 'log' the vertical cliff successions (by desk study and local expert knowledge) to produce a coastal stratigraphy assessment. This assessment was then used to develop the cliff erosion susceptibility dataset, which formed part of the Coastal Vulnerability Dataset (V1) in 2016 (Jenkins et al., 2017). Since this methodology was developed, a review has been carried out for fitness for purpose and updates have been implemented to this method to improve the analysis and data content. In addition, further experts have 'logged' the vertical cliff successions of the GB islands and the Scottish mainland, previously omitted from the dataset. Geologists assigned LEX-RCS codes to each stratigraphic unit for each cliff section. Lithology 1 is the geology at the base of the cliff or shoreline above the High-Water Line, through to Lithology 8 at the top of the cliff (where present). Geologists also assigned scores to the input datasets (BGS Civils Discontinuities, Strength, and BGS Permeability Index) based on their engineering and hydrological properties. These scores were used in a scoring template using look-up tables to match each 'logged' LEX-RCS code with an equivalent score for the three input datasets. The scores were processed through a coastal erosion susceptibility algorithm to determine a final score, normalised from 0 – 100 for erosion susceptibility. This score was then divided by equal intervals to create the 5 classes (low, low-moderate, moderate, moderate-high, high).

The superficial deposits in much of Scotland form a thin 'cap' on top of the bedrock and therefore, where present, raised the average score. This was considered unrealistic in many cases as any coastal erosion would be resisted primarily by the strong underlying bedrock (e.g. Lewisian gneiss). It was therefore agreed to add a Lithology 1 Class output to the attributes so that the basal lithological unit, most at risk of wave erosion, could be identified according to stakeholder needs.

3.2.4 Coastal profiling

The coastal profile is a key element of any coastal assessment and is intricately linked to the underlying geological properties. In GB, many coastal communities are located on top of, or protected by, an abrupt change in elevation. This dataset contains cliff height elevations that have been extracted through an automated process and derived from a national Digital Elevation Terrain model. Data are provided for the entire GB coastline denoting elevations of the cliff height, the cliff angle and the elevation range. Cliff top, toe and breaks of slope are defined here in purely geometric terms as an abrupt change/break in slope across a coastal transect. Cliff top and toe elevations have been extracted from a Digital Terrain Model (DTM) provided by Bluesky International Ltd. This is a 5 m resolution DTM comprised of both aerial photogrammetry and airborne LiDAR data that covers GB and the islands. The dataset has a multi-temporal resolution from 2006 with the majority of data being available post-2015 to 2017. The vertical uncertainty of the dataset is estimated as being ± 0.5 m.

The fields 'Height_m', 'Slope_Deg', and 'Range_m' attributes are calculated using transects every 10 m along the coast. For each transect, the DTM has been used to identify the

significant breaks of slope (>10 degrees change in slope between the upslope and downslope either side of a point) along the length of transect. This includes each convex and concave break of slope, which in areas of complex cliff profiles, are then grouped into similar profile patterns in order to define the single major break of slope aligning to the cliff top or cliff toe. Criteria are used to identify the first major rise in topography moving away from the coast and to isolate this from further more moderate changes in slope (e.g. where there is a continuous rising slope above a cliff, the top of the cliff is used and not the top of the subsequent slope). This method has been found to work well, especially in profound relief, however in areas of very low-relief, the top and toe are more difficult to determine and the results have a lower confidence. The output is a point dataset, aligned to the high-water line, attributed with values for cliff height, slope angle and slope range, and then displayed in the 50 m grid format.

3.2.5 Inundation UKCP18

Coastal inundation caused by sea level rise is of increasing concern for many areas of Great Britain. Even where defences have been installed, it is now becoming increasingly clear that many of these will not provide sufficient protection as sea levels continue to increase. This dataset provides an estimation of the coastal inundation extent based on UK climate projections (UKCP18) during the 21st century. The data is processed in segments on a British National Grid 100km square basis for three different years (2050, 2080 and 2100) using the median (RCP4.5) UKCP18 sea-level rise scenario. A simple method has been used to extract the sea level rise values for the target year from the nearest UKCP18 data point, calculate a horizontal inundation surface and intersect the DTM in areas of positive difference. All surfaces were extrapolated using the OS high water polyline as the baseline. UKCP18 Sea-level rise data (as point data) RCP4.5 (the 50th percentile) was used. This is the intermediate scenario, described as: "Approximately in line with the upper end of combined pledges under the Paris Agreement. The scenario "deviates mildly from a 'no-additional climate-policy' reference scenario, resulting in a best-estimate warming around 2.7C by the end of the 21st century". Similar has been confirmed by the Glasgow COP26 conference (November 2020), therefore this scenario is the closest to the agreement that world governments are trying to achieve. See https://www.carbonbrief.org/in-depth-qa-the-ipccs-sixth-assessment-report-on-climate-science for further information.

Other scenarios are available and could be processed according to need. The source data used was from https://ukclimateprojections-ui.metoffice.gov.uk/products/MS4_Anomalies_Subset_01

3.2.6 Coastal subsidence potential

Subsidence is the lowering or collapse of the ground, and is possible where the ground material can be displaced into an underground void space. It can be triggered by anthropogenic disturbance (e.g. mining), a change in drainage patterns, heavy rain or by water abstraction. At the coast there are additional complications due to the interactive effects of erosion and landsliding, and the effects of extremely high-tides and storm surges. Subsidence has the potential to cause engineering problems such as damage to foundations, buildings and infrastructure. Subsidence events can be associated with solution caves in karst, natural cavities in salt or gypsum, mining of coal and other rocks, or erosion of chalk (e.g. Birling Gap, East Sussex). Ground shrinkage can also occur in very porous, deformable rocks such as clays (e.g. Fairlight Cove, East Sussex), in fine-grained, low density soils such as windblown loess or rapidly deposited alluvial silts, in highly compressible soils such as peat, and in made ground or fill materials.

Based on the pan-European FP7 project SubCoast, carried out in 2010, the method was tailored and adapted to GB-level assessment using 1:50 000 scale geological data (BGS Geology 50K), geological properties and lithology thicknesses. Lithological units were classified on a numerical scale based on their susceptibility to subsidence and % expected reduction in volume. Persistent Scatterer Interferometry (PSI) data were used to calculate an independent measure of actual ground motion over large spatial areas. Calibration statistics of annual velocities were used to derive subsidence rates.

3.2.7 Groundwater flooding zones

This dataset identifies areas within the coastal zone that are susceptible to coastal inundation as well as groundwater flooding. In these areas, assets or habitats are potentially at risk from coastal flooding (by the sea) and have the additional potential to be exacerbated or prolonged by groundwater flooding. This could be especially important for building foundations and other buried assets (such as utilities) in the coastal zone. A simple yes/no dataset has been created to highlight where issues might occur. The BGS Susceptibility to Groundwater Flooding was combined with lithologies from the foreshore and backshore identified as geological indicators of past coastal flooding from the sea.

3.2.8 Coastal domains

The intention of the coastal domains dataset is to group similar sections of the coast based on primary sets of parameters; the susceptibility of the coastline to erosion, the presence or absence of a buffer between direct wave action and the coastline geology, and the height and profile shape of the coastline. This approach to classifying the coast has been implemented to capture the processes that we as Environmental Scientists consider when comparing one coastal area with another. By providing this classified dataset, this will enable coastal practitioners to consider best practise in certain regions, enabling the consideration of multiple datasets through a simple high-level scheme. As with all typologies, the domains developed through this work present a simplified version of reality (Scott et al., 2011). To our knowledge, this is the first time such an approach has been applied across England, Scotland and Wales using such a contiguous dataset as has been available for this implementation. This will therefore serve as a method for describing the GB coastline that is completely data driven and independent of administrative boundaries. The geomorphology of the GB coastline is complex and is directly influenced by the diverse geology of the British Isles. This variability is difficult to represent and consider when working in this environment so consequently geological influences are often underrepresented in coastal modelling and management planning. Numerous classification approaches (or typologies – see Buddemeier et al., 2008) have been developed regionally using different approaches, albeit often morphodynamically (following Wright et al., 1979) based (e.g. Wright and Short, 1984; Masselink and Short, 1993; Jennings and Schulmeister, 2002), with a GB specific approach having been devised more recently (Scott et al., 2011). Methods for classification vary in terms of the variables considered and the intended users (e.g. coastal managers or ecologists). Therefore, whereas some classifications incorporate multiple variables, others focus on specific parameters, such as cliff type or geometry (e.g. Payo et al., 2020). Morphodyamics in this context relate to how morphology is considered to affect coastal processes and relates to morphology, tide and wave activity and sediment transport (Friedrichs, 2011).

The variables used include erosion mean class, backshore sediment intersection, cliff Height, profile range. In addition to the datasets detailed above which were used to define the Coastal Erosion and Coastal morphometry domain groups, additional information was also used to develop the domain descriptions. These include coastal erosion variation that describes the variance in erosion susceptibility class of the coastal geology in each grid cell. The coastal erosion variation data contains 5 classes, 1 – 5, where 1 means there is no variation in the erosion susceptibility class in that cell and 5 means that the cliff contains rock types which represent all 5 erosion susceptibility scores in that cell. This dataset does not indicate the erosion susceptibility class of the rock types in the cliff, but rather the range in the erosion susceptibility classes within that cell.

3.3 SOURCE DATASETS

The GeoCoast data product is implemented in a Geographical Information System (GIS) using multiple datasets to describe the coastal stability and morphology as well as the geological susceptibility and properties of the coast of Great Britain. Twenty-eight source/input datasets (as listed below), comprising both BGS and third-party data, were used to derive the resulting layers. The datasets were selected to contribute to a better understanding and characterisation of coastal processes and stakeholder needs. The datasets were identified as the best available

at the time of the GeoCoast Product creation. The datasets used to create and validate the GeoCoast layers are shown in Table 2 below.

Table 2: Source datasets used in the development of GeoCoast

GeoCoast Premium	
GeoCoast layer	**Input datasets**
Coast grid	Foreshore zone: • OS Open Map Local April 2019 - TidalWater • OS Open Map Local April 2019 - Foreshore • BGS Geology 50K v8 (Bedrock) • BGS Geology 50K v8 (Superficial) • BGS Geology 50K v8 WMS (Superficial) • PGA Air photos (colour RGB) (Captured at 1:10 000 scale and 25cm resolution) Backshore zone: • OS Open Map Local April 2019 - TidalWater • OS Open Map Local April 2019 - Foreshore • BGS Geology 50K V8 WMS (Superficial) • BGS Geology 50K V8 (Superficial) • OS NATGRID (100K grid) • Inundation UKCP18 sea level rise • OS Open Map Local April 2019 - TidalWater • OS Boundary-Line™ May 2019 - High_water_polyline (+ derived from Tidal Water) • OS Open Map Local April 2019 - Foreshore • The Bluesky™ DTM (5 m resolution) (Bluesky International Ltd) • UKCP18 Sea-level rise data RCP4.5 SubcoastGB • BGS Geology 1:50 000 • BGS GeoSure: Compressible Ground v8 • BGS GeoSure: Soluble Rocks v8 • BGS GeoSure: Shrink-Swell v8 • BGS Superficial thickness model - ASTM
Erosion susceptibility	• BGS Geology 50K superficial, bedrock, mass movement • BGS Civils: Strength • BGS Civils: Discontinuities • BGS Permeability v7 • PGA Air photos
Groundwater flood zones	• GeoCoast Backshore • GeoCoast Foreshore • BGS Groundwater flooding susceptibility • BGS Geology 50K v8 (Superficial)
GeoCoast Open	
Statistics	• OS Open Data: OS Boundary-Line™ May 2019: High_water_polyline OS Boundary-Line™ May 2019: District_borough_unitary_region OS Strategi® 2016: Urban Region OS Vectormap® Local - 2019: Building OS Vectormap® Local - 2019: Road OS Vectormap® Local - 2019: Railway Track OS Vectormap® Local - 2019: Railway Station • ONS Output Areas: Population Data 2011 • BGS GB_Inundation_2100_2080_2050 • SEPA layer SCOTLAND_FRM_LPD_Border_Corrected • EA *Shoreline Management Plan* • GeoCoast Premium datasets
Coastal Domains	• BGS Coastal erosion susceptibility (mean class) • BGS Backshore sediments • BGS Cliff height • BGS Profile range • BGS Coastal erosion variation

Historic data	• 1:50 000 scale BGS series maps (cross section diagrams) • BGS Memoirs • BGS Sheet Explanations • BGS Regional Guides • BGS GSI3D project data

4 Technical Information

This section provides more detailed information on the data product and its content, the component suite of datasets provided and an explanation of each of the attributes.

4.1 SCALE

The GeoCoast datasets are intended for use at 1:50 000 scale. All spatial searches of the maps should be undertaken using a minimum 50 m buffer. This is because the smallest detectable feature at this scale is 50 m by 50 m in size.

4.2 COVERAGE

Each dataset has coverage of the coastline for Great Britain, except for the islands of Shetland and Orkney.

The maximum inland extent is equivalent to the maximum spatial extent of all modelled input data, primarily this is the maximum extent of flooding derived from UKCP18 data (Met Office Hadley Centre, 2018) in conjunction with the Bluesky elevation model (DTM). The backshore extent is classed as the maximum inland extent of all mapped coastal deposits. No clipping or buffering has been applied to the data and so the model comprises information that is compiled directly, with no moderation/modification for the various scales of input.

4.3 ATTRIBUTE DESCRIPTIONS

4.3.1 GeoCoast Premium: Coastal Properties Grid attributes

The coastal properties gridded dataset is a 50 m vector grid that provides a suite of data and information detailing the geological properties of the different coastal zones, including the foreshore, backshore, potential subsidence, potential inundation under climate change scenarios, cliff properties and summary cliff erosion susceptibility. Table 3 present these attributes.

Table 3: Attribute descriptions for GeoCoast Premium: Coastal Properties Grid

Attribute field	Description	Classes
CoastType	A simple 4-fold classification that identifies the coastal situation for each grid cell.	Offshore (zone below low water line) Foreshore (zone between low and high-water line) Backshore (zone between the high-water line and the landward limit of coastal deposits) Onshore (zone above high-water line to max inundation extent)
Foreshore	The foreshore classification is interpreted from expert knowledge, mapping and aerial photographs. It is spatially defined as the zone between low and high water line.	Beach BeachTidalFlat BeachWaveCutPlatform Saltmarsh SaltmarshBeach SaltmarshBeachTidalFlat SaltmarshTidalFlat TidalFlat WaveCutPlatform No Data None

LEX_RCS	The primary two-part, LEX & RCS, code used to label the geological units in BGS Geology50. LEX = Lexicon of rock nomenclature (the age of rock/deposit), RCS = Rock classification system (the type of rock/deposit).	Full descriptions for all 186 LEX-RCS codes listed in this attribute field can be accessed via the links below. LEX: https://www.bgs.ac.uk/Lexicon/ RCS: https://www.bgs.ac.uk/bgsrcs/
LEX	The LEX code.	Full descriptions for LEX codes listed in this attribute field can be accessed via the link: https://www.bgs.ac.uk/Lexicon/
Narrative	Brief description of the deposits and their spatial setting.	A free-format text description
Inund_Date	The time interval of maximum inundation extent derived from UKCP18 modelled sea level rise. [UKCP18 data RCP4.5].	2020 2050 2080 2100
Pot_Subs	The potential percentage subsidence for an area considering the combined effects of the superficial and bedrock geologies. Takes into account the potential for the deposit to compact, compress, dissolve, shrink and analysed with satellite-derived motion rates.	0, 1 2 3 4 5 6 25 33 90 % This is a potential volume change the bedrock material could undergo given the optimal conditions. A value of 90 indicates the material could undergo a 90% reduction in volume given the optimal conditions. 0 means the material cannot undergo volume change. -999 indicates no data available
Subs_Rate	The subsidence rate, in mm per year that an area could potentially undergo given the geological factors at that location. Takes into account the potential for the deposit to compact, compress, dissolve, shrink and analysed with satellite-derived motion rates. Note: this is a relative subsidence due to the lithological properties and does not factor in isostatic rebound changes.	0 to -7.065 mm Values are either zero or negative, a negative value indicates the amount of downwards motion that area could potentially undergo given the optimum natural conditions for the geological processes, which could drive subsidence. -999 indicates no data available
Height_m *[1]	Estimated cliff height in metres, determined from DTM analysis. Measured from high-water line to cliff top.	0-10, 10-30, 30-60, 60-100, >100. Plus a 'No Data' class
Slope_Deg *[1]	The estimated maximum angle of slope of the cliff between high-water line and the cliff top.	0-3, 3-10, 10-30, 30-50, >50. Plus a 'No Data' class
Range_m *[1]	The distance from the high-water line to cliff top calculated in metres.	0-100, 100-200, 200-300, >300. Plus a 'No Data' class
Mean_Cls	The mean erosion susceptibility classification of the cliff or backshore deposits. This is the range within which the erosion susceptibility score lies.	Consists of five categories, rated low, low-moderate, moderate, moderate-high, high. More than one deposit can be recorded, especially in higher cliffs in areas of complex geology
Worst_Cls	The worst case erosion susceptibility classification of the cliff or backshore deposits. This is the range within which the erosion susceptibility score lies.	Consists of five categories, rated low, low-moderate, moderate, moderate-high, high. More than one deposit will be recorded, especially in higher cliffs
Lith1_Cls	The base lithology (lith1) erosion susceptibility classification of the cliff. This is the first lithology above high-water line that will be predominantly subjected to wave processes.	Consists of five categories, rated low, low-moderate, moderate, moderate-high, high. More than one deposit will be recorded, especially in higher cliffs
MassMovemt	Indication of past slope instability as mapped, based on BGS Geology 50K.	Present, Not present, No Data
MassM_Desc	Brief description of slope instability where present.	No record of past instability at time of map compilation, Presence of past instability has been recorded, however current stability is unknown, No Data

Product	The name and version of the parent product.	GeoCoast_v1
Dataset	The name of the component dataset.	Coastal_Properties_Grid_*region*

*[1] The fields 'Height_m', 'Slope_Deg', and 'Range_m' attributes are calculated using transects located every 10 m along the coast. For each transect, the DTM has been used to identify the breaks of slope along the length of transect (where the rate of change of slope increases or decreases sharply). This includes each convex and concave break of slope, and in areas of complex cliff profiles (e.g. Figure 4 below), these are then grouped into similar profile styles to define the single major break of slope aligning to the cliff top or cliff toe. This method has been found to work well, especially in areas where geology creates pronounced cliff profiles. However, in areas of very low-relief, the cliff top and cliff toe breaks of slope are more difficult to determine and will have more uncertainty due to the limits of vertical resolution of the DTM.

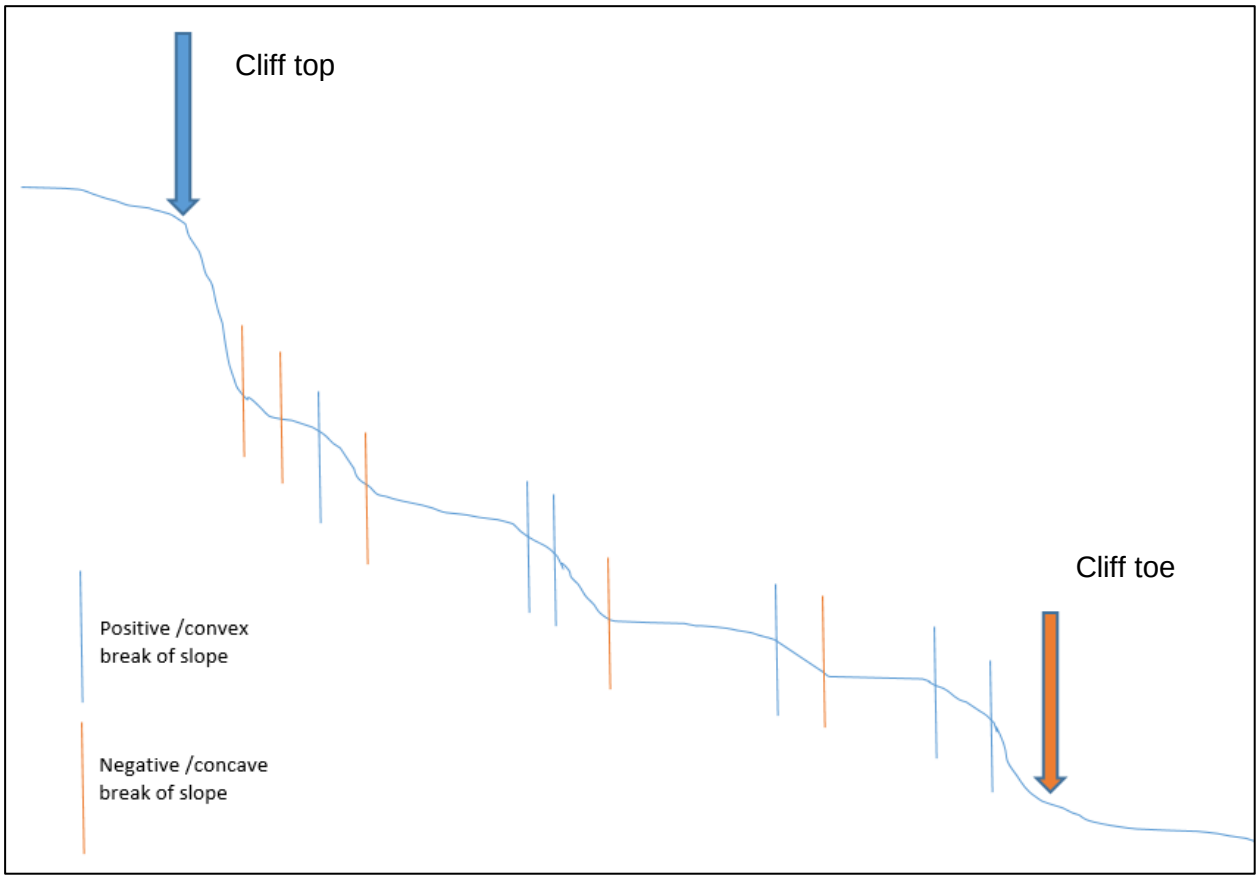

Figure 4: Example of the break of slope method to identify cliff top and toe heights.

4.3.2 GeoCoast Premium: Groundwater flooding zones attributes

The Groundwater flooding zones data provides a binary (yes/no) identification of areas where susceptibility to groundwater flooding and coastal seawater flooding spatially **co-exist** and thereby exacerbate, or prolong, flood events. Only areas where the two hazards coincide are provided, additional flood areas from the separate flooding sources could be more widespread. Users should also refer to the Environment Agency's coastal flood extent dataset: Risk of Flooding from Rivers or Sea.

Table 4: Attribute descriptions for GeoCoast Premium: groundwater flooding zones

Attribute field	Description	Classes
CLASS	The co-extent of both groundwater and inundation flooding.	Groundwater flood susceptibility zone
DESCRIPTN	A description of the classification.	Areas that are susceptible to groundwater flooding and coastal inundation e.g. by storm event. Groundwater flooding could exacerbate or impact on coastal flood hazards and prolong flood events.

AREA_M	Area of the polygon record, rounded up to the nearest metre.	A range between 2,500 – 15,1007,534 sq metres
PRODUCT	The name and version of the parent product.	GeoCoast_v1
DATASET	The name of the component dataset.	Groundwater_Flooding_Zones

4.3.3 GeoCoast Premium: Coastal Erosion Susceptibility

The coastal erosion susceptibility data have been provided as a separate dataset due to its importance in assessing the coast/cliff properties and stability.

It considers a suite of geological engineering properties for cliff sections (and low-lying deposits) around the GB coastline. The data is a result of a detailed vertical cliff analysis by expert geologists to provide the sequence of lithologies present in any given cliff section of the coast. The analysis then assesses key lithological properties, including presence of discontinuities, material strength and permeability. The aim is to help to identify the areas of coastline that could be more, or less susceptible, to erosion. The susceptibility scoring and classification **only considers** the rock/sediment properties themselves, not any man-made features such as coastal defences or previous instability (landslides). The outputs are described in the table below.

Note: in cases where the LEX_RCS codes are repeated e.g. lithology 1: TILLD-DMTN and lithology 2: TILLD-DMTN this is because the till deposits are identified as different units of different composition and/or possibly different ages but are not yet recognised in the BGS Lexicon.

Table 5: Attribute descriptions for GeoCoast Premium: coastal erosion susceptibility

Attribute field	Description	Classes
Height_m	Cliff height in metres determined from DTM analysis. Measured from high-water line to cliff top.	0-10, 10-30, 30-60, 60-100, >100. Plus a 'No Data' class
Slope_Deg	The maximum angle of slope of the cliff between high-water line and the cliff top.	0-3, 3-10, 10-30, 30-50, >50. Plus a 'No Data' class
Range_m	The distance from the high water line to cliff top calculated in metres.	0-100, 100-200, 200-300, >300. Plus a 'No Data' class
Lithology1 to Lithology8	The primary two-part, LEX & RCS code used to label the geological units in BGS Geology. Lithology 1 is the lowest base lithology at the bottom of a cliff. Each increase in lithology number is an additional rock type moving upwards in succession.	Full descriptions for all 186 LEX-RCS codes listed in this attribute field can be accessed via the links below. LEX: https://www.bgs.ac.uk/Lexicon/ RCS: https://www.bgs.ac.uk/bgsrcs/ No Data
Lith1_Scr to Lith8_Scr	The erosion susceptibility score for each geological unit within a cliff succession. Based on assessment of strength, discontinuities and permeability.	0-100
Mean_Scr	The mean erosion susceptibility score of all geological units present within a cliff succession. Score is based on assessment of strength, discontinuities and permeability.	0.2-100
Mean_Cls	The mean erosion susceptibility classification of the cliff or backshore deposits. This is the range within which the erosion susceptibility score lies. More than one deposit can be recorded, especially in higher cliffs.	Consists of five categories, rated low, low-moderate, moderate, moderate-high, high.
Worst_Scr	The worst-case erosion susceptibility score of all geological units present	0.2-100

	within a cliff succession. Based on assessment of strength, discontinuities and permeability.	
Worst_Cls	The worst case erosion susceptibility classification of the cliff or backshore deposits. This is the range within which the erosion susceptibility score lies. More than one deposit can be recorded, especially in higher cliffs.	Consists of five categories, rated low, low-moderate, moderate, moderate-high, high.
Lith1_Cls	The base lithology (lith1) erosion susceptibility classification of the cliff. This is the first lithology above high water mark that will be predominantly subject to wave processes. More than one deposit can be recorded, especially in higher cliffs.	Consists of five categories, rated low, low-moderate, moderate, moderate-high, high.
Complexity	An indication of the variability within a cliff, identifies the range of erosion susceptibility classes present e.g. All lithologies class moderate=0; min class is low, max class is high=4	0 - 4
MassMovemt	Indication of past slope instability as mapped, based on BGS Geology 50K.	Present, Not present, No Data
MassM_Desc	Brief description of slope instability where present.	No record of past instability at time of map compilation, Presence of past instability has been recorded, however current stability is unknown, No Data
Product	The name and version of the parent product.	GeoCoast_v1
Dataset	The name of the component dataset.	Coastal_Erosion_Susceptibility

4.3.4 GeoCoast Open: County Coastline Statistics

A range of regional, summary statistics have been generated from the baseline datasets to provide a county-level (based on the 'administrative units' from OS Boundary-line data) overview of coastal characteristics, cliff erosion and flood susceptibility. These are all provided under an Open Government Licence.

The table below shows the overall attributes for the combined county coastline statistics. Full individual tables for each dataset are provided in Appendix 1.

Table 6: Attribute descriptions for GeoCoast Open: Administrative Unit coastline statistics

Attribute field	Description	Classes
ADM_UNIT (see *2)	Administrative Unit name (from field 'FILE_NAME' in OS Boundary-Line district_borough_unitary_region.shp 371 entries).	Text field
COAST_KM	The length of coastline in kilometres per county.	Numeric field
SECTIONS	The total number of polyline segments (sections) that make up the coastline of each county e.g. number of islands making up a region, a breaks for estuaries.	1-1381
PERIM_KM	The whole county perimeter calculated from the OS Boundary Line county boundary data given in kilometres.	Numerical value in km
PER_COAST	The percentage of the county perimeter that is coastline.	0-100
HIGH_KM	Length of coastline per county in kilometres with a high susceptibility score the length of coastline with a high score is determined for all coastal sections assuming a) worst-case score per cliff profile, and b) mean score per cliff profile.	Numerical value in km

PER_HIGH	Percentage of coastline per county with a high susceptibility score (as calculated assuming worst-case, and mean cliff profile scoring).	0-100%
MULTI_KM	Length of coastline that is made up of multiple geological formations within a section of cliff given in kilometres per county.	Numerical value in km
PER_MULTI	The percentage of the total coastline length per county that is made multi formation cliffs.	0-100%
INUND2050	The length of coastline per county at risk of inundation in the 2050s. Based on UKCP18.	Numerical value in km
PER_2050	The percentage of the total length of coastline per county that is at risk of inundation in the 2050s.	0-100%
INUND2080	The length of coastline per county at risk of inundation in the 2080s. Based on UKCP18.	Numerical value in km
PER_2080	The percentage of the total length of coastline per county that is at risk of inundation in the 2080s.	0-100%
INUND2100	The length of coastline per county at risk of inundation in the 2100s. Based on UKCP18.	Numerical value in km
PER_2100	The percentage of the total length of coastline per county that is at risk of inundation in the 2100s.	0-100%
PRODUCT	The name and version of the parent product.	GeoCoast_v1
DATASET	The name of the component dataset.	Authority_Coastline

Note that this dataset will be also be available from the BGS GeoIndex online resources.

4.3.5 GeoCoast Open: SMP & LPD Coastline statistics (Shoreline Management Plans/Local Plan Districts)

A range of regional statistics have been generated from the GeoCoast premium datasets to provide Shoreline Management Plan & Local Plan Districts (Scotland) level overviews of coastal characteristics, cliff erosion and flood susceptibility. These are provided under an Open Government Licence and include the data described in the table below. The table below shows the overall attributes for the combined SMP and LPD statistics. Full individual tables for each dataset are provided in Appendix 1.

Table 7: Attribute descriptions for GeoCoast Open: SMP & LPD Coastline (Shoreline Management Plan) statistics

Attribute field	Description	Classes
LPD_SMP	The name of the Shoreline Management Plan.	Text field
ADM_UNIT (see *[2])	The name of the Distinctive Administrative Unit (from field 'FILE_NAME' in the OS Boundary-Line district_borough_unitary_region.shp).	Text field
SECTIONS	Number of sections of coastline per LPD/SMP.	Numerical value
COAST_KM	Length of coastline in kilometres per LPD/SMP.	Numerical value in km
MULTI_KM	Length of coastline that is made up of multiple geological formations within a section of cliff given in kilometres per county.	Numerical value in km
PER_MULTI	The percentage of the total coastline length per LPD/SMP that is made multiple geological formation cliffs.	0-100%
HIGH_KM	Length of coastline per county in kilometres with a high susceptibility score. The length of coastline with a high score is determined for all coastal sections assuming a) worst-case score per cliff profile, and b) mean score per cliff profile.	Numerical value in km

PER_HIGH	Percentage of coastline per county with a high susceptibility score (as calculated assuming worst-case, and mean cliff profile scoring).	0-100%
INUND2050	The length of coastline per LPD/SMP at risk of inundation in the 2050s. Based on UKCP18.	Numerical value in km
PER_2050	The percentage of the total length of coastline per LPD/SMP that is at risk of inundation in the 2050s. Based on UKCP18.	0-100%
INUND2080	The length of coastline per LPD/SMP at risk of inundation in the 2080s. Based on UKCP18.	Numerical value in km
PER_2080	The percentage of the total length of coastline per LPD/SMP that is at risk of inundation in the 2080s. Based on UKCP18.	0-100%
INUND2100	The length of coastline per LPD/SMP at risk of inundation in the 2100s.	Numerical value in km
PER_2100	The percentage of the total length of coastline per LPD/SMP that is at risk of inundation in the 2100s. Based on UKCP18.	0-100%
PRODUCT	The name and version of the parent product.	GeoCoast_v1
DATASET	The name of the component dataset.	SMP_Coastline

Note that this dataset will be also be available from the BGS GeoIndex online resources.

4.3.6 GeoCoast Open: Local Authority region statistics for inundation due to sea level rise

A range of regional, summary statistics have been generated from the GeoCoast Premium datasets and mapping of key infrastructure (such as railway, roads and urban areas) to provide a regional assessment of the potential impact of inundation arising from sea level rise. The data is based on the UK Climate Projections 2018 (UKCP18) and include statistics on the area and % of roads, railways and urban areas susceptibility under 2050, 2080 and 2100 climate scenarios. These data are provided under an Open Government Licence and include the information described in the table below.

Table 8: Attribute descriptions for GeoCoast Open: Administrative Unit region statistics for inundation sea level rise inundation.

Attribute field	Description	Classes
DAU (see *[2])	The name of the Distinctive Administrative Unit (from field 'NAME' in the OS Boundary-Line district_borough_unitary_region.shp, 371 entries).	Text field
ADM_UNIT (see *[2])	Administrative Unit name (from field 'FILE_NAME' in OS Boundary-Line district_borough_unitary_region.shp, 173 entries).	Text field
AREA_KMSQ	The total area of the Admininstrative Unit 1in km^2	Numerical value in square km
POPULATION	The total population of the Admininstrative Unit 1. Based on ONS Population 2011: Output Areas.	Numerical value
URBAN_KMSQ	The total area of urban coverage of the Distinctive Administrative Unit based on OS Open urban region (strategi).	Numerical value in square km
BUILD_KMSQ	The total area of building coverage of the Distinctive Administrative Unit based on OS Open buildings (vectormap district).	Numerical value in square km
ROAD_KM	The total length of roads within the Distinctive Administrative Unit based on OS Open road (vectormap district).	Numerical value in km
RAILWAY_KM	The total length of railway within the Distinctive Administrative Unit based on OS Open railway track (vectormap district).	Numerical value in km
RAILWAY_ST	The total number of railway stations within the Distinctive Administrative Unit based on OS Open railway station (vectormap district).	Numerical value
AREA_2050	Percentage area of Distinctive Administrative Unit at risk of inundation using 2050 scenarios. Based on UKCP18.	%

URBAN_2050	Percentage urban area of Distinctive Administrative Unit at risk of inundation using 2050 scenarios. Based on UKCP18.	%
BUILD_2050	Percentage buildings within Distinctive Administrative Unit at risk of inundation using 2050 scenarios. Based on UKCP18.	%
ROAD_2050	Percentage roads within Distinctive Administrative Unit at risk of inundation using 2050 scenarios. Based on UKCP18.	%
RW_2050	Percentage railways within LA at risk of inundation using 2050 scenarios. Based on UKCP18.	%
RWS_2050	Percentage railway stations within LA at risk of inundation using 2050 scenarios. Based on UKCP18.	%
AREA_2080	Percentage area of Distinctive Administrative Unit at risk of inundation using 2080 scenarios. Based on UKCP18.	%
URBAN_2080	Percentage urban area of Distinctive Administrative Unit at risk of inundation using 2080 scenarios. Based on UKCP18.	%
BUILD_2080	Percentage buildings within Distinctive Administrative Unit at risk of inundation using 2080 scenarios. Based on UKCP18.	%
ROAD_2080	Percentage roads within Distinctive Administrative Unit at risk of inundation using 2080 scenarios. Based on UKCP18.	%
RW_2080	Percentage railways within Distinctive Administrative Unit at risk of inundation using 2080 scenarios. Based on UKCP18.	%
RWS_2080	Percentage railway stations within Distinctive Administrative Unit at risk of inundation using 2080 scenarios. Based on UKCP18.	%
AREA_2100	Percentage area of Distinctive Administrative Unit at risk of inundation using 2100 scenarios. Based on UKCP18.	%
URBAN_2100	Percentage urban area of Distinctive Administrative Unit at risk of inundation using 2100 scenarios. Based on UKCP18.	%
BUILD_2100	Percentage buildings within Distinctive Administrative Unit at risk of inundation using 2100 scenarios. Based on UKCP18.	%
ROAD_2100	Percentage roads within Distinctive Administrative Unitat risk of inundation using 2100 scenarios. Based on UKCP18.	%
RW_2100	Percentage railways within Distinctive Administrative Unitat risk of inundation using 2100 scenarios. Based on UKCP18.	%
RWS_2100	Percentage railway stations within Distinctive Administrative Unitat risk of inundation using 2100 scenarios. Based on UKCP18.	%
INUND_2050	Inundation Risk Level within Distinctive Administrative Unit in 2050 = (AREA_2050 + URBAN_2050 + BUILD_2050 + ROAD_2050 + 0.5*RW_2050 + 0.5*RWS_2050) / 5.	%
CLASS_2050	Inundation Risk Class within Distinctive Administrative Unit in 2050.	Discrete Classes from 1 to 7
INUND_2080	Inundation Risk Level within Distinctive Administrative Unit in 2080 = (AREA_2080 + URBAN_2080 + BUILD_2080 + ROAD_2080 + 0.5*RW_2080 + 0.5*RWS_2080) / 5.	%
CLASS_2080	Inundation Risk Class within Distinctive Administrative Unit in 2080.	Discrete Classes from 1 to 7
INUND_2100	Inundation Risk Level within Distinctive Administrative Unit in 2100 = (AREA_2100 + URBAN_2100 + BUILD_2100 + ROAD_2100 + 0.5*RW_2100 + 0.5*RWS_2100) / 5.	%
CLASS_2100	Inundation Risk Class within Distinctive Administrative Unit in 2100.	Discrete Classes from 1 to 7
PRODUCT	The name and version of the parent product.	GeoCoast_v1
DATASET	The name of the component dataset.	Authority Area Inundation

*[2] Note about the use of OS Boundary-Line: Each entry in the district_borough_unitary_region.shp **NAME** field contains a unique value, totalling 371 entries (we call this DAU). The district_borough_unitary_region.shp **FILE_NAME** field often have several entries with the same value. See image below that shows the following example (the last five rows): for the CAMBRIDGESHIRE_COUNTY under FILE_NAME there are 5 different entries ('district') under NAME field. When creating the GeoCoast Open statistics, we dissolve the shapefile by FILE_NAME and obtain a new shapefile with 173 entries only (we call ADM_UNIT).

NAME	AREA_CODE	DESCRIPTIO	FILE_NAME
Bath and North East Somerset	UTA	Unitary Authority	BATH_AND_NORTH_EAST_SOMERSET
Bedford (B)	UTA	Unitary Authority	BEDFORD_(B)
Birmingham District (B)	MTD	Metropolitan District	BIRMINGHAM_DISTRICT_(B)
Blackburn with Darwen (B)	UTA	Unitary Authority	BLACKBURN_WITH_DARWEN_(B)
Blackpool (B)	UTA	Unitary Authority	BLACKPOOL_(B)
Blaenau Gwent - Blaenau Gwent	UTA	Unitary Authority	BLAENAU_GWENT_-_BLAENAU_GWENT
Bolton District (B)	MTD	Metropolitan District	BOLTON_DISTRICT_(B)
Bournemouth, Christchurch and Poole	UTA	Unitary Authority	BOURNEMOUTH,_CHRISTCHURCH_AND_POOLE
Bracknell Forest (B)	UTA	Unitary Authority	BRACKNELL_FOREST_(B)
Bradford District (B)	MTD	Metropolitan District	BRADFORD_DISTRICT_(B)
Bro Morgannwg - the Vale of Glamorgan	UTA	Unitary Authority	BRO_MORGANNWG_-_THE_VALE_OF_GLAMORGAN
Buckinghamshire	UTA	Unitary Authority	BUCKINGHAMSHIRE
Bury District (B)	MTD	Metropolitan District	BURY_DISTRICT_(B)
Caerdydd - Cardiff	UTA	Unitary Authority	CAERDYDD_-_CARDIFF
Caerffili - Caerphilly	UTA	Unitary Authority	CAERFFILI_-_CAERPHILLY
Calderdale District (B)	MTD	Metropolitan District	CALDERDALE_DISTRICT_(B)
Fenland District	DIS	District	CAMBRIDGESHIRE_COUNTY
South Cambridgeshire District	DIS	District	CAMBRIDGESHIRE_COUNTY
East Cambridgeshire District	DIS	District	CAMBRIDGESHIRE_COUNTY
Huntingdonshire District	DIS	District	CAMBRIDGESHIRE_COUNTY
Cambridge District (B)	DIS	District	CAMBRIDGESHIRE_COUNTY

Note that this dataset will be also be available from the BGS GeoIndex online resources.

4.3.7 GeoCoast Open: Historic records

This data compilation is provided as a quick-reference source for any relevant coastal sections, figures or photographs that are currently embedded within BGS memoirs and reports.

There are large amounts of information, particularly coastal cliff sections, cross sections and images that are currently 'locked' away in individual BGS Memoirs, reports and documents, which are not currently easily accessible or catalogued. The aim of this data layer is to start making this data more accessible as hyperlinked data. This historic data ranges in scale and date of capture, and therefore provides a snapshot in time and allows coastal changes to be identified. The data is provided via the **BGS GeoIndex**.

Data has been sourced from: 1:50 000 scale BGS Geology series of maps (cross section diagrams), BGS Memoirs, BGS Sheet Explanations, BGS Regional Guides, and BGS GSI3D geological models.

Table 9: Attribute descriptions for GeoCoast Open: Historic images and sections

Attribute field	Description
UID	Unique identifier
DOC_No	Figure or plate number in the publication
LOCATION	Nearest place name
EASTING	Grid reference in BNG
NORTHING	Grid reference in BNG
SHEET_No	The geological 1:50 000 scale map sheet reference number
SOURCE	The BGS publication type (e.g. New series memoir, Regional Guide, Sheet Explanation)
SOURCE_D	The title of the publication
SOURCE_L	The hyperlink to the publication
YEAR	The year of publication
IMAGE_L	The hyperlink to the digital image file
PRODUCT	The name of the dataset feature layer: e.g. Historic_Data
DATASET	GeoCoast_v1

Note: *IPR STATEMENT relating to the historic images and sections:*

To meet with BGS's commitment to the continuing openness of its data, the materials available through this portal are viewable under the Open Government Licence. This licence is subject to the following acknowledgement accompanying any use of the material: "British Geological Survey © UKRI [2022] ".

In some instances material released under this portal contains not only BGS, but identified third party data. Where third party data is not covered by the OGL, users wishing to reuse any of this data must gain direct permission from the appropriate copyright owner to do so.

If you are a copyright holder and are concerned that you have found material on the portal belonging to you, and have not granted permission for this use, please contact the BGS IPR team. Please ensure you include the below information in any communication:

1. *Your contact details.*
2. *The full bibliographic details of the material.*
3. *The exact and full URL where you found the material.*
4. *Proof that you are the rights holder and a statement confirming that you are the rights holder or are an authorised representative.*

Given proof of valid objection, BGS will take down the relevant material from the portal.

4.3.8 GeoCoast Open: Coastal domains attributes

The intention of the coastal domains dataset is to group 'similar' sections of the coast based on two primary sets of parameters;

(1) the susceptibility of the coastline to erosion and the presence or absence of a buffer between direct wave action and the coastline geology, and
(2) the height and profile shape of the coastline.

This approach to classifying the coast has been implemented to capture the processes that we, as geoscientists, consider when comparing one coastal area with another. By providing this domain analysis, we aim to offer coastal practitioners an additional tool to consider/share best practise at a regional scale, and streamline the consideration of multiple underlying datasets through a simple high-level scheme. The outputs are described in Table 10 below. Table 11 and Table 12 below describe the individual attributes for the Erosion domain and Profile domains (respectively), along with example localities typical of each domain class.

Table 10: Attribute descriptions for GeoCoast Open: Coastal domains

Attribute field	Description	Classes
ErosionDom	The erosion domain class	A - J
ErosionSus	Erosion susceptibility description	Low - high
ErosionBac	Description of presence or absence of backshore	Generally an absence of backshore above high water mark; Generally backshore area is present above high water mark
ProfileDom	The coastal profile domain class	1 - 11
ProfileH	The height of the coastal profile, describes the difference in elevation between high water and the top of the coastal profile	Very low: 0-10m Low: 10-30m Moderate: 30-100m High: >100m
ProfileR	The range of the coastal profile, describes the horizontal distance between the high-water mark and the highest part of the coastal zone	Low: 0.100m Middle: 100-200m High: >200m
smp	Reference to the relevant shoreline management plan area	
Product	The name of the parent product	GeoCoast_V1
Dataset	The name of the component dataset	Coastal_Erosion_Profile_Domains

Table 11: Attribute descriptions for coastal erosion classification: Erosion domains

ErosionDom	ErosionSus	ErosionBac	Erosion variation	Examples
A	Typically low susceptibility to erosion	Generally an absence of backshore area above HWM	No variation in erosion susceptibility: the coastline is dominated by geology that possesses a uniform resistance to erosion with little or no (98.2%) variation in the erosion class.	Isle of Skye, Fingal's cave, St David's Head, Lands' End, Great Orme
B	Typically low susceptibility to erosion	Generally backshore area is present above high water mark	No variation in erosion susceptibility: the coastline is dominated by geology that possesses a uniform resistance to erosion with no (96.8%) variation in the erosion class.	Rhosneiger (Anglesey), Bude bay/river mouth, St Ives
C	Typically low-moderate susceptibility to erosion	Generally an absence of backshore area above high-water mark	Low variation in erosion susceptibility: the coastline is dominated by geology that possesses a slightly variable resistance to erosion with no (78.4%), limited (13.9%) and some (6.4%) variation in the erosion class.	Brighstone Bay IOW, Needles, Scratchells Bay, Lulworth Cove, Beachy Head, St Bees Head
D	Typically low-moderate susceptibility to erosion	Generally backshore area is present above high water mark	Low variation in erosion susceptibility: the coastline is dominated by geology that possesses a relatively uniform resistance to erosion with no (75.5%) or limited (18.2%) variation in the erosion class.	Sidmouth Dunnet Head, Beaumaris, Polzeath, Porth Leven–Gunwalloe (Looe Bar), Seaford
E	Typically moderate susceptibility to erosion	Generally an absence of backshore area above high-water mark	Moderate variation in erosion susceptibility: the coastline is dominated by geology that possesses a variable resistance to erosion with common (51.6%), some (30.9%) and no (10.6%) variation in the erosion class.	Runswick Bay, Valley of the Rock (Lynton), St Agnes headland
F	Typically moderate susceptibility to erosion	Generally backshore area is present above high water mark	High variation in erosion susceptibility: the coastline is dominated by geology that possesses a variable resistance to erosion with common (37.2), no (25.7%), some (22.0%) and limited (13.2%) variation in the erosion class.	Studland Bay, Flamborough Head, Bexhill on sea
G	Typically moderate-high susceptibility to erosion	Generally an absence of backshore area above high-water mark	High-very high variation in erosion susceptibility: the coastline is dominated by geology that possesses a variable resistance to erosion with very common (51.6%), no (25.8%), common (10.5%) and limited (9.8%) variation in the erosion class.	Skipsea, Filey Bay, Banff, Blackpool (north), Alborough (Yorks)
H	Typically moderate-high susceptibility to erosion	Generally backshore area is present above high water mark	Low variation in erosion susceptibility: the coastline is dominated by geology that possesses a slightly variable resistance to erosion with no (66.4%), very common (16.6%) and limited (10.5%) variation in the erosion class.	Llanrhidian Sands (Gower), Lymington, Mundesley, Cartmel Sands (Ulverston), Deal
I	Typically high susceptibility to erosion	Generally an absence of backshore area above high-water mark	Very low variation in erosion susceptibility: the coastline is dominated by geology that possesses a relatively uniform resistance to erosion with no (89.7%) or limited (10.0%) variation in the erosion class.	Dunbar, Lee on Solent, Gosport, Cuckmere Haven
J	Typically high susceptibility to erosion	Generally backshore area is present above high water mark	Very low – low variation in erosion susceptibility: the coastline is dominated by geology that possesses a uniform resistance to erosion geology with no (83.3%) or limited (16.7%) variation in the erosion class.	Romney Marsh, Dungeness, Holkham, Beadnell/Bamburgh, Southport

Table 12: Attribute descriptions for coastal profile classification: Profile domains

ProfileDom	ProfileH	ProfileR	Description	Examples
1	Very Low	Low	A very low height and low range coastline. The coastline is typically low-lying and commonly backed by very low cliffs, hills, prominent gravel ridges or sand dunes.	Cley next the Sea, north Norfolk;
2	Very Low	Middle or High	A very low height but middle to high range coastline. This coastline is typically low-lying and marked by gentle gradients. This may include areas of cliffs (slipped) or more open coastline (e.g. salt marsh, tidal flats, low dunes, estuaries).	Holkham, north Norfolk; Newborough Warren, Anglesey; Studland Bay, Dorset;
3	Low	Low	A low height and low range coastline. The coastline is typically backed by low, steep cliffs.	West Runton, north Norfolk; Aldbrough, East Yorkshire; Malltraeth Bay, Anglesey; Seacombe Cliffs, Dorset
4	Low	Middle	A low height and middle range coastline. The coastline is typically backed by low, sloping cliffs and / or a wider beach.	Winterton-on-Sea, Norfolk
5	Low	High	A low height and high range coastline. The coastline is typically backed by small, gently-sloping cliffs or hills and / or a wider beach.	Sidmouth (West cliffs), Devon.
6	Moderate	Low	A moderate height and low range coastline. The coastline is typically backed by moderate, steep cliffs.	Sheringham (east), north Norfolk
7	Moderate	Middle	A moderate height and middle range coastline. The coastline typically has an undulating profile with moderate cliffs. The enhanced range may be influenced by hillslopes above the cliff, coastal landslides and a wider beach.	Trimingham, north Norfolk; Bempton, Yorkshire;
8	Moderate	High	A moderate height and high range coastline. The coastline is typically backed by moderate cliffs. The enhanced range may be influenced by hillslopes above the cliff, coastal landslides and a wider beach.	Speeton, Yorkshire; Praa Sands, Cornwall; West Bexington, Dorset.
9	High	Low	A high height and low range coastline. The coastline is typically backed by high, steep cliffs.	Beachy Head, East Sussex
10	High	Middle	A high height and middle range coastline. The coastline is typically backed by high cliffs. The enhanced range may be influenced by hillslopes above the cliff, coastal landslides and a wider beach.	Branscombe, Devon. Sidmouth (East cliffs), Devon
11	High	High	A high height and high range coastline. The coastline is typically backed by high cliffs. The enhanced range may be influenced by hillslopes above the cliff, coastal landslides and a wider beach.	Ravenscar, Yorkshire; Rousdon, Dorset.

Note that this dataset will also be available from the BGS GeoIndex online resources.

4.4 DATA FORMAT

The GeoCoast datasets have been created as vector grids (also known as cellular grids) and are available in ESRI ArcGIS (.shp) GIS formats. Other spatial formats such as geopackages may be available but may incur additional processing costs.

4.5 DATASET HISTORY

GeoCoast version 1 is a new data product released in 2022. It has incorporated and improved upon the Coastal Vulnerability Dataset (Jenkins *et al.*, 2017), which has now been superseded.

4.6 DISPLAYING THE DATA

The BGS GeoCoast data is provided as:

GeoCoast Open:

- Historic Data: only available via the BGS GeoIndex
- Statistics: 11 shapefiles and available via the BGS GeoIndex
    - GeoCoast_v1_Authority_Coastline_Cliff_Erosion_MEAN.shp
    - GeoCoast_v1_Authority_Coastline_Cliff_Erosion_WORST.shp
    - GeoCoast_v1_Authority_Coastline_Inundation.shp
    - GeoCoast_v1_Authority_Coastline_Length.shp
    - GeoCoast_v1_Authority_Coastline_Multi_Formations.shp
    - GeoCoast_v1_Authority_Area_Inundation.shp
    - GeoCoast_v1_SMP_Coastline_Cliff_Erosion_MEAN.shp
    - GeoCoast_v1_SMP_Coastline_Cliff_Erosion_WORST.shp
    - GeoCoast_v1_SMP_Coastline_Inundation.shp
    - GeoCoast_v1_SMP_Coastline_Length.shp
    - GeoCoast_v1_SMP_Coastline_Multi_Formations.shp

  To help with understanding these statistics, 16 layer files have been created. Some examples of these statistical visualisations are illustrated in Figure 5.

- Coastal Domains: 1 shapefile and 2 layer files and available via the BGS GeoIndex
    - GeoCoast_v1_Erosion_Profile_Domains.shp
    - GeoCoast_v1_Erosion_Domains.lyr
    - GeoCoast_v1_Profile_Domains.lyr

GeoCoast Premium:

- Coastal properties grid: 10 shapefiles (divided into GB-wide 100km grid areas for faster processing) and 3 layer files. Available per SMP region or nationally.
    - GeoCoast_v1_Coastal_Properties_Grid_EW_NE.shp
    - GeoCoast_v1_Coastal_Properties_Grid_EW_NW.shp
    - GeoCoast_v1_Coastal_Properties_Grid_EW_EM.shp
    - GeoCoast_v1_Coastal_Properties_Grid_EW_WM.shp
    - GeoCoast_v1_Coastal_Properties_Grid_EW_SE.shp
    - GeoCoast_v1_Coastal_Properties_Grid_EW_SW.shp
    - GeoCoast_v1_Coastal_Properties_Grid_SCT_NE.shp
    - GeoCoast_v1_Coastal_Properties_Grid_SCT_NW.shp
    - GeoCoast_v1_Coastal_Properties_Grid_SCT_E.shp
    - GeoCoast_v1_Coastal_Properties_Grid_SCT_W.shp
    - Coastal_Properties_Grid_Lith1Cls.lyr
    - Coastal_Properties_Grid_SubsRate.lyr
    - Coastal_Properties_Grid_Inundation.lyr

- Coastal erosion susceptibility: 2 shapefiles (one merged with the NCERM data) and 3 layer files. Available per SMP region or nationally.
    - GeoCoast_v1_Coastal_Erosion_Susceptibility.shp
    - GeoCoast_v1_Coastal_Erosion_Susceptibility_NCERM.shp
    - GeoCoast_v1_Coastal_Erosion_Susceptibility_Lith1_Cls.lyr
    - GeoCoast_v1_Coastal_Erosion_Susceptibility_Mean_Cls.lyr
    - GeoCoast_v1_Coastal_Erosion_Susceptibility_Worst_Cls.lyr
- Groundwater flooding zones: 1 shapefile. Available per SMP region or nationally.
    - GeoCoast_v1_Groundwater_Flooding_Zones.shp

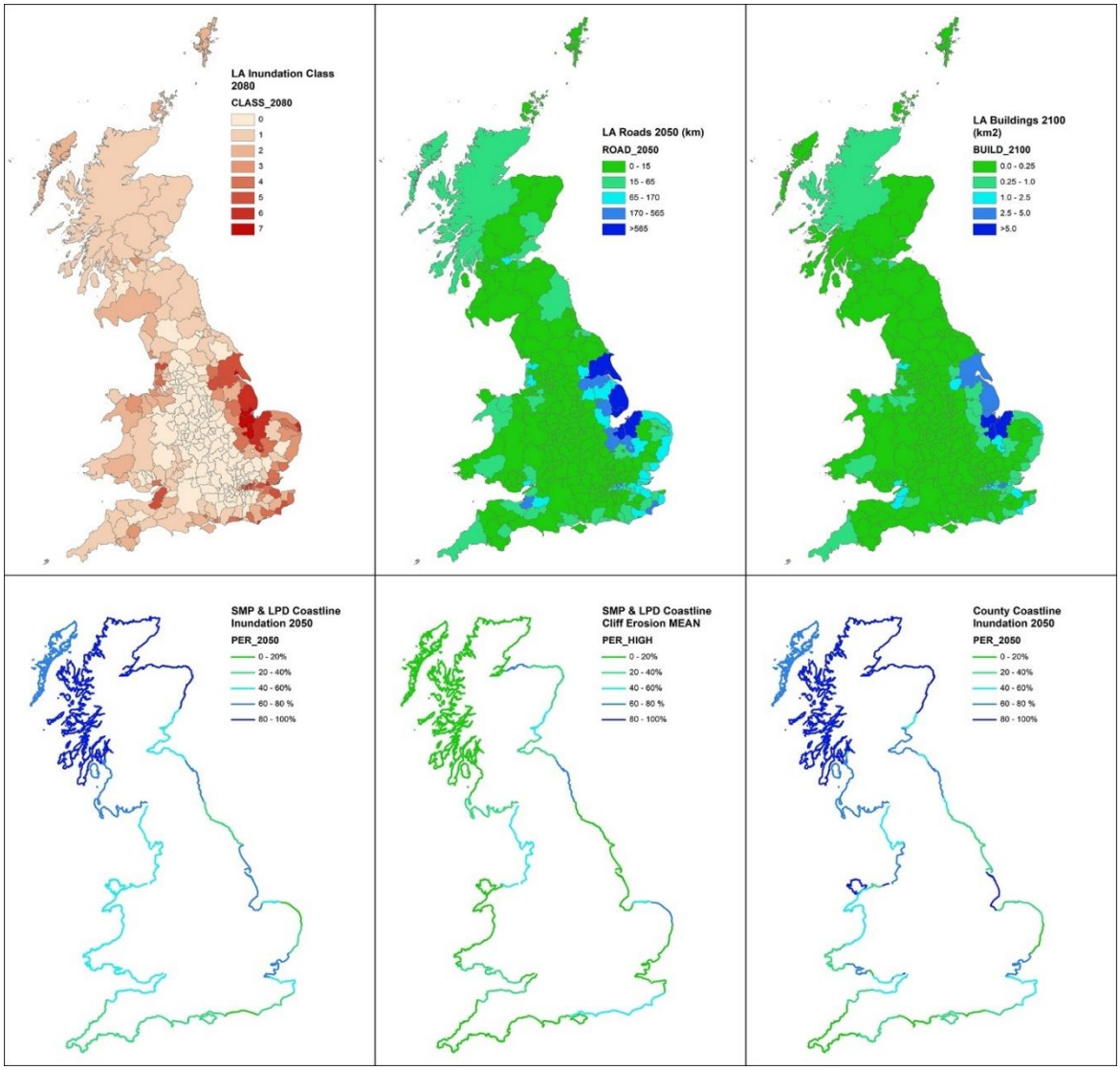

Figure 5: Example outputs of the GeoCoast statistic datasets

5 Licencing the data

5.1 BGS LICENCE TERMS

The British Geological Survey does not sell its digital mapping data to external parties. Instead, BGS grants external parties a licence to use this data, subject to certain standard terms and conditions. In general, a licence fee will be payable based on the type of data, the number of users, and the duration (years) of a licence.

All recipients of a licence (potential licensees) are required to return a signed digital data licence document before authorisation for release of BGS digital data is given.

In general terms, a BGS digital data licensee **will** be permitted to:

- make internal use of the dataset(s)
- allow a specified number of internal users to access/use the data (the number of users will be agreed with the licensee and specified in the licence document) for the purposes of their day-to-day internal activities
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But **will not** be permitted to:

- provide a bureau service for others or incorporate the data in the generation of products or services for commercial purposes
- sell, assign, sublicense, rent, lend or otherwise transfer (any part of) the dataset(s) or the licence
- place (any part of) the dataset(s) on the Internet

The BGS is committed to ensuring that all the digital data it holds which is released to external parties under licence has been through a robust internal approval process, to ensure that geoscientific standards and corporate quality assurance standards are maintained. This approval process is intended to ensure that all data released: (i) is quality assured; (ii) meets agreed BGS data management standards; (iii) is not in breach of any 3rd party intellectual property rights, or other contractual issues (such as confidentiality issues), that would mean that release of the data is not appropriate.

When the BGS digital datasets are revised any upgrades will be automatically supplied to the licensee, at no additional cost. Geological map datasets are revised on a periodic rather than on an annual basis, licensees will therefore not automatically receive a new dataset each year unless changes have been made to the data.

These are general comments for guidance only. A licensee of BGS's digital data is provided with full details of the basis on which individual BGS datasets licensed to them are supplied.

If you have any doubts about whether your proposed use of the BGS data will be covered by a BGS digital licence, the BGS Intellectual Property Rights (IPR) section will be happy to discuss this with you and can be contacted through the following email address: iprdigital@bgs.ac.uk BGS IPR will usually be able to provide reassurance that the licence will cover individual user requirements and/or to include additional 'special conditions' in the licence documentation, addressing specific requirements within BGS's permitted usage.

5.2 DATA ACKNOWLEDGEMENTS

Please use the following acknowledgements when using BGS GeoCoast.

GeoCoast Premium licenced data: ‘Derived from BGS Digital Data under Licence (cite your licence number) British Geological Survey © UKRI. All rights reserved.’

GeoCoast Open data: ‘Contains British Geological Survey materials © UKRI [year]’

5.3 CONTACT INFORMATION

For all data and licensing enquiries please contact:

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6 Limitations

6.1 DATA CONTENT

The BGS GeoCoast datasets consider the natural geology and properties around the coastal zone of Great Britain.

BGS GeoCoast is concerned with potential ground stability related to NATURAL geological conditions only. GeoCoast does NOT cover any man-made hazards, such as contaminated land or mining or human influences such as coastal defences. The data has used the OS high water polyline as a consistent baseline on which to hang the data, therefore there may be instances where sea walls and harbour walls are attributed with properties however these properties relate to the natural ground behind the defences.

BGS GeoCoast is based on, and limited to, an interpretation of the records in the possession of the British Geological Survey at the time the dataset was created. All data layers are derived from the most up-to-date version of the 1:50 000 geological maps and best available associated input layers.

The information provided in these data are designed for DESK STUDY phases and give an indication of potential issues from the mapped geological information. An indication of natural erosion susceptibility does not necessarily mean that a location will be affected by erosion, ground movement, or subsidence. Equally, an indication of flood inundation does not necessarily mean that a location will be affected by flooding. Site-specific assessment can only be made by inspection of the area by a qualified professional. Such assessments should be carried out by suitably qualified and experienced professionals and using appropriate methods.

6.2 SCALE

The GeoCoast data are produced for use at 1:50 000 map scale providing 50 m ground resolution, and must not be used at larger scales. All spatial searches against the data should be done with a minimum 50 m buffer.

6.3 ACCURACY/UNCERTAINTY

The mapping accuracy associated with the BGS GeoCoast datasets is based on that of the BGS Geology 50K dataset. This is nominally 1 mm which equates to 50 m on the ground at 1:50 000 map scale. This is only a measure of how faithfully the lines are captured. Consequently, this dataset must not be used at scales finer than 1:50 000.

The creation of the individual data layers relies upon a number of assumptions regarding the procedure and technical methodology. The procedures for the assessment of these methodologies were largely based upon the expert judgement of geologists, engineering geologists and extensive discussion with district geologists. Further technical assumptions were also made:

- The description given by LEX-RCS is correct and representative of the lithology.
- Surface geology is correctly represented by BGS Geology 50K.
- Lithologies are consistent across formations and the coding system represents the spread of data.
- Expert judgement and BGS data sources are appropriate and applied consistently.
- Processes within the shallow subsurface are properly represented by the distribution of data as modelled from BGS Geology 50k and the data extracted from the National Geotechnical Database.
- The surface slope model derived from the Bluesky DTM is accepted as providing a reasonable model of slope morphology.
- The Superficial Deposits Thickness Model is accurate and represents a reasonable model of the thickness of Quaternary-age, unconsolidated deposits.
- UKCP18 data are accurate and represent a reasonable model of climate change parameters.
- Satellite data: Persistent scatterer interferometry data and interpretations for ground motion are accurate as developed under the PanGeo FP7 project & OneGeology-Europe, and present a reasonable measurement of ground deformation.
- Ordnance Survey data are an accurate representation of locations, features and boundaries.

- Not all LEX_RCS codes from BGS Geology 50k were present in the BGS Civils datasets. BGS Civils is based on BGS Geology V6 (published 2010), whereas BGS Geology 50k is currently V8 (published 2017). Therefore, appropriate replacement LEX_RCS codes from V6 were substituted for the purpose of the scoring matrix. It should be noted that, in Scotland particularly, a number of areas have been updated with substantial map changes and these have not been included in this version because of the restrictions to availability of BGS Civils V6. Partly for this reason we have included the Lithology_1 class as an additional attribute, thereby allowing a focus on the bedrock/basal geology where needed.
- Sections of coastline that are structurally geologically complex have been simplified. Without the benefit of detailed local knowledge or field observations it is difficult to ascertain the precise geological succession within the cliff. Geologists have 'logged' the coast as accurately as possible and wherever local knowledge exists.
- The islands of Orkney and Shetland are not available in this version of the dataset; please contact digitaldata@bgs.ac.uk for further details.
- Evidence of coastal landslides have been included based on BGS Geology 50K mass movement data only. These data are based on, and limited to, an interpretation of the records in the possession of The British Geological Survey at the time the data set was created.

6.4 ARTEFACTS

Geological mapping: The mapping accuracy associated with the BGS GeoCoast datasets is based on that of the BGS Geology 50K dataset, which represents data from different times and origins of survey. This can result in inconsistencies between older, and more recently gathered, observations (such as boreholes). Consequently, adjacent geological sheets/tiles (of different survey dates) may not seamlessly fit together spatially, or in terms of lithological description. This can result in some map-sheet 'edges' that exhibit contrasting colours/attribution. This in turn can affect the representation of the GeoCoast layers.

Artificial structures: GeoCoast only considers the natural features of the coastline. In some locations, artificial features including sea walls and harbours may carry the attributes of the geology that lies behind. This is related to how the GeoCoast data grid has been calculated.

Coastal erosion scores: Erosion scores are not available at all locations around GB as with other variables delivered as part of the GeoCoast product. These data gaps relate to the limits of the extent of the project focus when expert regional geologists identified the coastal lithologies. The focus is on seaward coast rather than estuarine.

GeoCoast domains: The GeoCoast domains classifications are based on other variables delivered as part of the GeoCoast data product (GeoCoast Premium). Any inherent issues within these datasets (e.g. missing erosion scores) will therefore translate through to the Domains data. Although these are limited in extent, users should be aware of their potential occurrence.

6.5 DISCLAIMER

Components of the GeoCoast datasets are developed using climate scenario data obtained from 3rd parties. Whilst BGS strives to make its products as accurate as possible, we can offer no warranty about fitness-for-purpose or accuracy of information. Furthermore, the information provided is the result of modelled output and thus provided as 'best available', scientifically modelled data only.

GeoCoast V1, released by BGS in 2022, incorporates the UK Climate Projections 2018 (UKCP18) released under the Met Office Hadley Centre Climate Programme in its Inundation data. This provides projections for the median UKCP18 sea-level rise scenarios for five different years (2020, 2050, 2080, 2100 and post 2100). The use of the data product and its limitations is the user's responsibility and BGS accepts no liability for data variability. The data is based on

100 km square basis, users should also be aware that other scenarios are available at different resolutions. Further advice as to product limitations is available on request.

7 Frequently asked questions

The questions and answers below have been provided to address any potential issues relating to how the product can be used or how it can be interpreted. If you have any additional questions, please contact digitaldata@bgs.ac.uk

Q: What is the BGS GeoCoast data product?

A: GeoCoast is an integrated GIS package of datasets designed to inform about geological and climate change factors that influence coastal evolution, and to support stakeholders seeking to assess coastal management and adaptation.

Q: What does GeoCoast include?
A: GeoCoast Premium contains information on the morphology, properties and vulnerability of the coastline, underpinned by its geology and its coastal context (profile, height, etc.) It includes information on coastal erosion susceptibility, modelled inundation under different climate scenarios, potential subsidence and cliff profiles. In addition, there are a suite of open datasets (GeoCoast Open) that provide summary data at County, Local Authority and Shoreline Management Plan levels.

Q: How can GeoCoast be used?

A: GeoCoast can be used to underpin coastal decision making and planning relative to coastal inundation, erosion and climate change impacts. The datasets are compatible with Shoreline Management Plan areas. Being in GIS format, it is easily combined with other geospatial data.

Q: Who is GeoCoast for?
A: It is targeted at all coastal practitioners including regulatory bodies, Local Authorities, asset owners.

Q: What data formats can be provided?
A: The GeoCoast dataset has been created as vector grids and are available in GIS ESRI format and geopackage. Other formats are available on request.

Q: What map scale is the GeoCoast dataset provided at?
A: The GeoCoast product and its component datasets are produced for use at 1:50 000 scale providing 50 m ground resolution, and must not be used at larger scales. All spatial searches against the data should be done with a minimum 50 m buffer.

Q: What area does the GeoCoast dataset cover?
A: The datasets have full national coverage for the coastal zone of Great Britain.

Q: Why do we need information about coastal properties and hazards?
A: Natural ground stability and flood hazards may lead to financial loss for anyone involved in the ownership or management of property, including developers, householders or local government. GeoCoast can be used to underpin coastal decision making and planning relative to coastal inundation, erosion and climate change impacts.
Armed with knowledge about potential hazards, preventative steps can be put in place to alleviate the impact of the hazard to people and property. The cost of such prevention may be low, and is often many times lower than the repair bill following ground movement. The identification and classification of these hazards can be of use to regional planners, local government offices, developers, homeowners, solicitors, loss adjusters, the insurance industry, architects and surveyors.

Q: What does it mean if my part of the coast has an erosion value of 90 or says 10% of the coast is high susceptibility?

A: The erosion scores are created by analysing the lithological properties within a cliff or coastal slope. These scores range from 0-100 (low – high susceptibility). Each lithology within a coastal slope will have a score therefore it is important to consider the range of lithologies where present also. A high lithology 1 score would suggest that the area has a higher susceptibility to wave erosion. A high worst case class would mean that one or more lithologies within that coastal section have a high susceptibility. An indication of coastal erosion does not necessarily mean that a location will be affected by coastal processes, especially if the area has coastal defences. Such an assessment can only be made by inspection of the area by a qualified professional.

Q: Why is the premium dataset delivered as a cellular grid and not a line?
A: The final gridded output is designed to streamline the multiple key datasets and potential factors that impact on coastal processes. Rather than having multiple layers, the data will be combined to create an easy-to-use dataset that contains all the relevant data necessary for a coastal assessment. The gridded format (50 m grid cells) helps to convey to users the accuracy limitations of the data rather than having a specific vector line that users often perceive as a precise location, particularly where shorelines are concerned.

Q: Why do some grids cells have missing data?
A: Not all attributes will be present for all grid cells, it depends on the location e.g. foreshore, backshore, or the hazard e.g. future inundation, groundwater flooding. for example, a grid cell showing the extent of inundation under climate change will have a greater extent that the foreshore or cliff erosion and therefore, these attribute will not be present as the data is not relevant.

Q: How are the 5 erosion classes divided?
A: A coastal erosion susceptibility algorithm is used (based on lithology strength, permeability and discontinuities) to determine a final score, and normalised from 0 – 100 for erosion susceptibility. This score is then divided by equal intervals to create the 5 classes (low, low-moderate, moderate, moderate-high, high).

Q: Why are sea defences not included?
A: The GeoCoast data represents the natural properties present along the GB Coastline and therefore doesn't consider the impact of coastal defences. This is because it is important to understand the natural properties as well as the range of practices in use. Not all areas will have defences, some will be degraded, no longer maintained and/or have differing shoreline management plans, and there is no nationally consistent source of data on coastal defence condition. It is also useful to consider that if defences are removed from areas of similar characteristics, might the coastal processes behave as at other locations and can lessons be learned/shared. It should also be considered that some defences will not provide sufficient protection as sea levels continue to increase.

Q: Does the erosion susceptibility algorithm take into account areas of previous landslide instability?

A: The current erosion susceptibility analysis looks at the strength, permeability and discontinuities within and between different layers of strata/lithologies. The calculation does not include any previous instability because the process of coastal erosion is complex, previous instability might make the coast less susceptible initially, increasing susceptibility over time as wave erosion undermines to toe of a landslide for example. However, the rate and frequency of these processes are difficult to predict. However, we have included an attribute 'mass movement' that provides an indication of where past instability has occurred and this is derived from the BGS Geology mass movement dataset.

Q: Why do you not provide data on erosion extents or rates?

A: GeoCoast does not go as far as providing predicted extents of erosion or erosion rates due to the inherent uncertainties associated with coastal erosion processes. There are multiple complex influencing factors, both natural and artificial, that mean that predicting the timing and

extent of erosion is extremely difficult at a national scale. However, GeoCoast does plug this data-gap and provides a suite of geological properties data at a more granular scale that can be used by stakeholders as key components within a modelling environment alongside additional factors such as defences, tidal currents, wave heights, etc.

Q: How accurate is this dataset?
A: The mapping accuracy associated with the GeoCoast dataset is primarily based on that of the BGS Geology 50K dataset. Derived by vector capture from paper map archives, this data has a nominal +/-1 mm precision at map scale (1:50 000), which equates to +/-50 m in real space. This is only a measure of how faithfully the lines were captured from their legacy paper-map sources. Consequently, this dataset must not be used at scales finer than 1:50 000. The UKCP18 sea level rise data is based on 100 km^2 gridded data. The mapping of the vertical cliff lithologies are created through expert knowledge and are based on 1:10 000 – 1:50 000 scale mapping knowledge.

Q: Are the values in the dataset real world observations or predictions?
A: The datasets derived as part of the GeoCoast product are predicted values based on real world values, and on the expert judgement of engineering geologists and district geologists with regional expertise.

Q: How often will this dataset be updated?
A: The current version (V1) was released in 2022. The dataset will be revised when sufficient source data is updated and there is a user demand. An ongoing programme of product development is in place and frequent reviews will determine when a new version of the dataset will be released.

Q: Can I use this dataset as part of a commercial application?
A: If you would like to use this for commercial applications, please contact us at: digitaldata@bgs.ac.uk

Glossary

Jargon	Explanation
ArcGIS	Geographic information system (GIS) software for working with maps and geographic information maintained by the Environmental Systems Research Institute (ESRI).
Bedrock	The main mass of rocks forming the earth, laid down prior to 2.588 million years ago. Present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground or water. Formerly called solid.
Compressible Ground	Layers of very weak deposits (peat, clay) that compress if loaded by overlying structures, or if the groundwater level changes.
Consolidation	Compaction and cementation of sediments to the degree that they become coherent, relatively solid rock. Typical consequences of consolidation include an increase in density and a decrease in porosity/volume.
Digital Terrain Mode (DTM)	Digital terrain model (DTM) that incorporates the elevation of important topographic features on the land. This has been processed to remove anthropogenic artefacts such as buildings etc.
Discontinuities	Discontinuities are breaks, fractures or planes of weakness in the rock mass (e.g. joints, bedding, foliation). Definitions on spacing of discontinuities are derived from BS5930.
Dissolution	Process of water passing through soluble material such as gypsum, halite (rock salt) or limestone (including chalk). The result of this process is dissolved areas such as cave, sinkholes, sinking streams and large springs, creating a landscape known as karst.
Erosion	The gradual destruction and removal of rock or soil in a particular area by rivers, the sea, or the weather.
Erosion susceptibility	Susceptibility of erosion occurring at a given location. Characteristic that describes an inherent tendency, or capacity, to erode under action of wind or water.
Expert Elicitation	Essentially a scientific consensus methodology. It is often used in the study of rare / unlikely events, and allows for a collective ‘educated guess’ by experts for the respective topic under study. It generally quantifies uncertainty of an event or phenomena that has a significant ‘random’ probability of occurrence.
Geohazard	Geological and environmental conditions, involving long and short-term processes which may lead to widespread damage. There are many different types of geohazard with different natural and artificial processes causing them to occur. All have the potential to create problems for development of the human environment and threats to the safety and well-being of people. Geohazards can develop quickly (seconds or minutes) in response to the processes that drive them, or take tens, hundreds, or thousands of years to develop to a point where they pose a danger. They are found in most parts of the world, including marine and fluvial environments.
Geotechnical	The application of technology to engineering problems caused by geological factors.
Ground Stability	The potential for upward, sideways or sinking movement of the ground (natural or man-made deposits) e.g. subsidence.

Hazard	A potentially damaging event or phenomenon.
Inundation	An overflow or flood of large amounts of water that overwhelm.
Landslide	The down-slope movement of materials. Usually occurs when particular slope characteristics (geology, gradient, sources of water, drainage, actions of people) combine to make the slope unstable.
LEX_RCS	A two-part attribute code describing the name of the geological unit(s) or deposit(s) represented and their composition. Lexicon (or LEX) computer code used to identify the rock unit(s) or deposit(s) as listed in the BGS lexicon of Named Rock Units. A rock-classification scheme (RCS) code of up to 6 characters (mostly letters forming the second part of the primary LEX-RCS attribute e.g. MDCO. The code can represent a single lithology or multiple lithologies.
Lexicon	Vocabulary defining rock names, the BGS Lexicon of Named Rock Units database provides BGS definitions of terms that appear on our maps and in our publications. https://www.bgs.ac.uk/lexicon/home.html
Lithology	Rocks maybe defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscope or chemical analysis for the latter to be fully determined.
Lithostratigraphy	Age and lithology. Many rocks are deposited in layers or strata and the sequence of these strata can be correlated from place to place. These sequences of different rocks are used to establish the changing geological conditions or geological history of the area through time. The description, definition and naming of these layered or stratified rock sequences is termed lithostratigraphy (rock stratigraphy). Lithostratigraphy is fundamental to most geological studies. Rock units are described using their gross compositional or lithological characteristics and named according to their perceived rank (order) in a formal hierarchy. The main lithostratigraphic ranks in this hierarchy are: Bed (lowest)>Member,>Formation>Subgroup>Group>Supergroup (highest). The units are usually named after a geographical locality, typically the place where exposures were first described.
Mass Movement	Primarily superficial deposits or weathered bedrock that have moved downslope under gravity to form landslips.
Polygon	Polygons are a representation of areas. A polygon is defined as a closed line or perimeter completely enclosing a contiguous space and is made up of one or more links.
Qualitative Classification	Qualitative data approximates and characterizes, it can be observed and recorded. This data type is non-numerical in nature. It is collected through methods of observations, allowing the determination of traits and characteristics.
Resolution	Resolution expresses the size of the smallest object in a spatial data set that can be described. It refers to the amount of detail that can be discerned. It is also known as granularity.

Risk	The impact of a hazard on people, property or capital.
Scale	The relation between the dimensions of features on a map and the geographic objects they represent on the earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 means that one unit of measure on the map equals 100,000 on the earth.
Shapefile	The shapefile format is a geospatial vector data format for geographic information system software. It is developed and regulated by ESRI as a mostly open specification for data interoperability among ESRI and other GIS software products.
Shrink–Swell	Materials containing clay minerals change in volume (increase/decrease) due to the variation in water content; volume change in geological materials can cause the ground to shrink or swell.
Subsidence	The process by which the ground beneath a building sinks to a lower level, pulling the property's foundations down with it.
Superficial	The youngest geological deposits formed during the most recent period of geological time, the Quaternary. They date from about 2.6 million years ago to the present.
Superficial Thickness Model	A raster (pixel-based grid) dataset designed to demonstrate the variation in thickness of Quaternary superficial deposits across Great Britain. Quaternary deposits are identified as all unconsolidated material deposited in the last 2.6 million years.
Vector	A representation of the spatial extent of geographic features using geometric elements (such as point, curve, and surface) in a coordinate space.

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Appendix 1

7.1 COUNTY COASTLINE STATS

Table 13: Attribute descriptions for the Authority_Coastline_Inundation dataset.

Attribute field	Description
ADM_UNIT	Administrative Unit name (from field 'FILE_NAME' in OS Boundary-Line district_borough_unitary_region.shp
COAST_KM	Length of coastline in kilometres per county
SECTIONS	Number of sections of coastline per county
INUND2050	The length of coastline per county at risk of inundation in the 2050s
PER_2050	The percentage of the total length of coastline per county that is at risk of inundation in the 2050s
INUND2080	The length of coastline per county at risk of inundation in the 2080s
PER_2080	The percentage of the total length of coastline per county that is at risk of inundation in the 2080s
INUND2100	The length of coastline per county at risk of inundation in the 2100s
PER_2100	The percentage of the total length of coastline per county that is at risk of inundation in the 2100s
PRODUCT	GeoCoast_V1
DATASET	Authority_Coastline_Inundation

Table 14: Attribute descriptions for the Authority_Coastline_Multi_Formations dataset.

Attribute field	Description
ADM_UNIT	Administrative Unit name (from field 'FILE_NAME' in OS Boundary-Line district_borough_unitary_region.shp
COAST_KM	Length of coastline in kilometres per county
MULTI_KM	Length of coastline that is made up of multi formation cliffs given in kilometres per county
PER_MULTI	The percentage of the total coastline length per county that is made multi formation cliffs
PRODUCT	GeoCoast_V1
DATASET	Authority_Coastline_Multi_Formations

Table 15: Attribute descriptions for the Authority_Coastline_Cliff_Erosion_WORST dataset.

Attribute field	Description
ADM_UNIT	Administrative Unit name (from field 'FILE_NAME' in OS Boundary-Line district_borough_unitary_region.shp
COAST_KM	Length of coastline in kilometres per county
SECTIONS	Number of sections of coastline per county
HIGH_KM	Length of coastline per county in kilometres with a high susceptibility score for the worst case scenario
PER_HIGH	Percentage of coastline per county with a high susceptibility score for the worst case scenario
PRODUCT	GeoCoast_V1
DATASET	Authority_Coastline_Cliff_Erosion_WORST

Table 16: Attribute descriptions for the Authority_Coastline_Cliff_Erosion_MEAN dataset.

Attribute field	Description
ADM_UNIT	Administrative Unit name (from field 'FILE_NAME' in OS Boundary-Line district_borough_unitary_region.shp
COAST_KM	Length of coastline in kilometres per county
SECTIONS	Number of sections of coastline per county

HIGH_KM	Length of coastline per county in kilometres with a mean susceptibility score of high
PER_HIGH	Percentage of coastline per county with a mean susceptibility score of high
PRODUCT	GeoCoast_V1
DATASET	Authority_Coastline_Cliff_Erosion_MEAN

7.1.1 SMP & LPD Coastline Stats

Table 17: Attribute descriptions for the SMP_Coastline_Length dataset.

Attribute field	Description
LPD_SMP	Shoreline Management Plan
COAST_KM	Length of coastline in kilometres per LPD/SMP
SECTIONS	Number of sections of coastline per LPD/SMP
PRODUCT	GeoCoast_V1
DATASET	SMP_Coastline_Length

Table 18: Attribute descriptions for the SMP_Coastline_Inundation dataset.

Attribute field	Description
LPD_SMP	Shoreline Management Plan
COAST_KM	Length of coastline in kilometres per LPD/SMP
SECTIONS	Number of sections of coastline per LPD/SMP
INUND2050	The length of coastline per LPD/SMP at risk of inundation in the 2050s
PER_2050	The percentage of the total length of coastline per LPD/SMP that is at risk of inundation in the 2050s
INUND2080	The length of coastline per LPD/SMP at risk of inundation in the 2080s
PER_2080	The percentage of the total length of coastline per LPD/SMP that is at risk of inundation in the 2080s
INUND2100	The length of coastline per LPD/SMP at risk of inundation in the 2100s
PER_2100	The percentage of the total length of coastline per LPD/SMP that is at risk of inundation in the 2100s
PRODUCT	GeoCoast_V1
DATASET	SMP_Coastline_Inundation

Table 19: Attribute descriptions for the SMP_Coastline_Multi_Formations dataset.

Attribute field	Description
LPD_SMP	Shoreline Management Plan
COAST_KM	Length of coastline in kilometres per LPD/SMP
MULTI_KM	Length of coastline that is made up of multi formation cliffs given in kilometres per LPD/SMP
PER_MULTI	The percentage of the total coastline length per LPD/SMP that is made multi formation cliffs
PRODUCT	GeoCoast_V1
DATASET	SMP_Coastline_Multi_Formations

Table 20: Attribute descriptions for the SMP_Coastline_Cliff_Erosion_WORST dataset.

Attribute field	Description
LPD_SMP	Shoreline Management Plan
COAST_KM	Length of coastline in kilometres per LPD/SMP
SECTIONS	Number of sections of coastline per LPD/SMP
HIGH_KM	Length of coastline per LPD/SMP in kilometres with a high susceptibility score for the worst case scenario
PER_HIGH	Percentage of coastline per LPD/SMP with a high susceptibility score for the worst case scenario

PRODUCT	GeoCoast_V1
DATASET	SMP_Coastline_Cliff_Erosion_WORST

Table 21: Attribute descriptions for the SMP_Coastline_Cliff_Erosion_MEAN dataset.

Attribute field	Description
LPD_SMP	Shoreline Management Plan
COAST_KM	Length of coastline in kilometres per LPD/SMP
SECTIONS	Number of sections of coastline per LPD/SMP
HIGH_KM	Length of coastline per LPD/SMP in kilometres with a mean susceptibility score of high
PER_HIGH	Percentage of coastline per LPD/SMP with a mean susceptibility score of high
PRODUCT	GeoCoast_V1
DATASET	SMP_Coastline_Cliff_Erosion_MEAN