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Authors : Mrs. Susan HANSON (UEA), Robert J Nicholls, Floris Calkoen

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Summary

Coastal geomorphology reflects geological inheritance and the production, storage and movement of sediments in response to changing water levels, and inputs of wind, tidal and wave energy, as well as human influences. The resultant processes of erosion, transport and deposition produce both desirable coastal features such as beaches, but also create erosion (and flood) hazards for coastal development. Hence, these processes have been increasingly modified and restricted by human action in order to reduce the risks of erosion and flooding on areas of social and economic value. To capture this historical context and the current ability of the coastal system to respond to changing water levels, a mixed approach was adopted for integrating relevant information into the erosion database. The erosion database is based around a qualitative coastal classification which defines a limited number of coastal geomorphic types. The approach is applied around Europe’s open coastline using about one million linear segments that follow the coastline. In each coastal segment, the most landward active geomorphic type is selected, stored in the erosion database and used in the analysis. These classes denote both the geomorphic type and identify if coastal defences and other artificial structures (e.g., a shore-parallel railway or road) constrain or limit their future geomorphic evolution. Existing databases such as EuroSION (on erosion), Corinne (on land cover), and Long-Term Shoreline Trends (1984 to 2021) provide inputs. The erosion database can be used to qualitatively explore how/if the coastal system may evolve, including consideration of rising sea levels. Qualitative descriptions of plausible management responses are built around combinations of the classification, land cover and shoreline movement which can be applied to investigate future shoreline management possibilities. The erosion database provides an improved reference dataset on Europe’s coasts suitable for local to continental scale coastal risk analysis.

Approval

Date	By
2024-02-29 13:19:15	Dr. Robert NICHOLLS (UEA)
2024-02-29 19:34:39	Dr. Gonéri LE COZANNET (BRGM)

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Executive summary

The EU-funded Coastal Climate Services (CoCliCo) Project is developing an open web-platform that will help inform decision-making on coastal risk and adaptation at multiple scales from the local, up to the scale of Europe. It is designed so that users of the platform will be able to visualise, download and analyse multiple decision-oriented coastal risk scenarios. While CoCliCo focusses mainly on flood risks, erosion risks are also relevant. Coastal erosion is the morphodynamic process by which the shoreline migrates landward due to sediment deficits from whatever cause. Some coasts are chronically erosive while others are less erosive or even accreting, although sea-level rise is expected to increase the erosional tendency. Erosion is also influenced by human activities in the coastal zone such as coastal defences which are often designed to stop erosion. Coastal erosion is important in adaptation as it can lead to the loss of socio-economically or environmentally important areas. Further it can also exacerbate the consequences of coastal flooding. However, the interactions between flooding and erosion are typically not considered.

Building on previous research, the 'GIS database of erosion for Europe v1' (henceforth 'erosion database') has been designed and constructed to characterise coastal geomorphology, better understand present and future erosional tendencies, and hence support coastal flood analysis around Europe's coasts. The erosion database is built on a Europe-wide coastal geomorphological classification, including consideration of the ability of the coastal system to respond to changes in sea level. This includes the effect of existing coastal structures on geomorphic evolution, especially how they may restrict geomorphic behaviour. Europe has a long history and legacy of coastal defence and hence this is a particularly important issue. By considering the coastal floodplain, the erosion database highlights where erosion and flooding coincide and may interact.

Coastal geomorphology reflects geological inheritance and the production, storage and movement of sediments in response to changing water levels, and inputs of wind, tidal and wave energy, as well as human influences. The resultant processes of erosion, transport and deposition produce both desirable coastal features such as beaches, but also create erosion (and flood) hazards for coastal development. Hence, these processes have been increasingly modified and restricted by human action in order to reduce the risks of erosion and flooding on areas of social and economic value. To capture this historical context and the current ability of the coastal system to respond to changing water levels, a mixed approach was adopted for integrating relevant information into the erosion database.

The erosion database is based around a qualitative coastal classification which defines a limited number of coastal geomorphic types. The approach is applied around Europe's open coastline using about one million linear segments that follow the coastline. In each coastal segment, the most landward active geomorphic type is selected, stored in the erosion database and used in the analysis. These classes denote both the geomorphic type and identify if coastal defences and other artificial structures (e.g., a shore-parallel railway or road) constrain or limit their future geomorphic evolution. Existing databases such as EuroSION (on erosion), Corinne (on land cover), and Long-Term Shoreline Trends (1984 to 2021) provide inputs. The erosion database can be used to qualitatively explore how/if the coastal system may evolve, including consideration of rising sea levels.

Qualitative descriptions of plausible management responses are built around combinations of the classification, land cover and shoreline movement which can be applied to investigate future shoreline management possibilities.

The erosion database provides an improved reference dataset on Europe's coasts suitable for local to continental scale coastal risk analysis.



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D4.2 GIS database of erosion for Europe_V1

1 Introduction

The EU-funded Coastal Climate Services (CoCliCo) Project is developing an open web-platform that will help inform decision-making on coastal risk and adaptation at multiple scales from the local up to the scale of Europe. To support this, the platform examines the main flood risk drivers and adjusts visualisation and analysis techniques to local decision contexts. It also combines important and high-quality geospatial information layers. It is designed so that users of the platform will be able to visualise, download and analyse multiple decision-oriented coastal risk scenarios.

In the context of CoCliCo, the ‘GIS database of erosion for Europe v1’ (henceforth ‘erosion database’) has been designed and constructed to characterise the coastal geomorphology and better understand present and future erosional tendencies around Europe’s open coasts to support coastal flood analysis. The GIS-based erosion database provides a qualitative Europe-wide coastal geomorphological classification based on the ability of the coastal system to respond to changes in sea level. This includes consideration of the effect of existing coastal structures that may restrict sediment movement and hence influence coastal geomorphic behaviour including erosion (following earlier analyses such as Hanson *et al.* (2010) and French *et al.* (2016). The effect of coastal defences on the coasts is often progressive and their influence grows with time. Further, once constructed, they need to be maintained, improved or replaced as conditions change, generating a commitment to coastal defence and overall management over time. Europe has a long history of coastal defence and hence this is a particularly important issue here. Additionally, erosion and flood risks are often analysed separately owing to the complex relationships between driving processes, morphological response and differing areas at risk. However, simultaneous erosion–flood events often occur as the same processes drive them, and systematic erosion can change the exposure of floodable areas (Pollard *et al.*, 2019). The erosion database highlights where the two risks coincide and may interact.

2 Approach

Coastal geomorphology on the open coast reflects the geological inheritance and the production, storage and movement of sediments in response to changing water levels, and inputs of wind, tidal and wave energy (see Davidson-Arnott *et al.*, 2019; Woodroffe, 2002) and human influences. The resultant processes of erosion, transport and deposition produce both desirable coastal features such as beaches, but also create erosion and flood hazards for coastal development. Hence, these



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processes have increasingly been modified and restricted by human action in order to reduce these risks on areas of social and economic value (André et al., 2016; Sauvé et al., 2023). To capture this historical context and the current ability of the coastal system to respond to changing water levels, a mixed approach was adopted for integrating relevant information into the erosion database.

The core of the analysis is a qualitative coastal classification. The classification defines a limited number of coastal geomorphic types which are distinguishable around Europe's coasts. This is applied around Europe's coastline using linear segments that follow the coastline. In each coastal segment, the most landward active geomorphic type is selected, stored in the erosion database and used in the analysis. The classes are named and described to denote both the geomorphological type and the extent to which coastal structures influence their geomorphic evolution (see Section 3). The analysis follows the EEA European coastline (EEA, 2017) which is compatible with the wider CoCliCo analysis. A GIS-based environment is used which allows a range of spatial datasets to be integrated (e.g., CLC, 2020; EEA, 2004) to create a database of erosion-related information (Section 3 and Appendix 7.1).

The erosion database can then be used to qualitatively explore how /if the coastal system is able to evolve, especially as the consequence of rising sea levels which are expected to exacerbate coastal erosion (Section 4). Qualitative descriptions of plausible management responses are built around combinations of the classification, land cover and shoreline movement which can be applied to investigate future shoreline movement possibilities.

3 Coastal database components

The erosion database uses the vertices of the EEA coastline to define fixed length line segments. This created over 1 million classified segments (70,00km) in a total coastline of 200,000 covering 31 countries to which other database components are assigned using spatial joins (See Section 5.1).



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3.1 Key definitions

Term		Definition
Coastal zone		An indicative zone of 100m width inland from the EEA coastline which might be impacted by erosion over the next 100 years
Floodplain		Area hydrologically connected to the ocean with an elevation below the local 1:100 sea elevation height (including surge) assuming a 2-m sea-level rise. Water levels are based on Global Tide and Surge Reanalysis (GTSR) plus a 2.0m allowance for sea-level rise
	Local	Within the coastal zone (100m of the coastline)
	Remote	Beyond 100m but any change in the geomorphology could affect flood events (e.g., barrier islands)
Land cover		As classified by the Corine 2018 land cover data set within the coastal zone
Coastal Structure		Any man-made structure or defence within the coastal zone which exerts an influence on the coastal geomorphic system, for example sea walls
Offshore structure		Structure, usually for defence purposes, located offshore that influences the coastal system (e.g., breakwaters)

Table 1 Key definitions in the erosion database

3.2 Coastal geomorphology-based classification

The classification uses the cross-shore combination of geomorphological features dividing the active coastal system into a limited number of coastal types based on geomorphology, elevation, form, and the presence/absence of man-made structures both on-and off-shore.

The coastal system is considered as an adaptive continuum covering the intertidal, backshore (e.g., beach) and landward geomorphological features. This profile is expected to migrate landward in response to a rise in sea level. For Europe, The active landward geomorphic feature is particularly important for erosion, especially when considering the potential impact on flooding. For Europe, the key geomorphological features are cliffs, dunes and wetlands. Coastal structures and defences provide both a break in this cross-shore continuum, leaving only a portion of the profile able to evolve, and a curb on this ability. This includes restrictive structures such as shore-parallel roads which also constrain geomorphic evolution (Section 3.3). Hence, following the initial differentiation between coastlines which are resistant to erosion and those that are erodible (largely taken from EUROSION data), the most landward active geomorphological unit is selected as the reference geomorphic feature on that profile and is stored in the erosion database. The presence or absence of human constraints due to structures is reflected in the descriptive geomorphic classes shown in Table 2. The main response to sea-level rise is for the coastal profile to move landward. For human-modified coastlines this is restricted and to indicate this two descriptive terms are added to the main classification. ‘*Constrained*’ indicates that landward migration is not possible due to the presence of a defence or other structure. Where coastal processes are curtailed by defences, but geomorphic change may still occur to landward due to aeolian or hydrological processes, or during extreme



events, the term ‘limited’ is applied. This generally applies where the defence comprises either groins or an offshore structure (Figure 1).

Geomorphological class	Human Influence	Description
Erosion-resistant coast	N/A	Hard rock formations (often cliffs), fronted by mobile sand and coarser sediments or rock, which are slow to recede at a human timescale. Can include pocket beaches.
Erodible cliffs	None	Steeply rising land of erodible material, fronted by mobile sand and coarser sediments or rock, which are liable to recede
	Limited	Steeply rising land of erodible material fronted by cross or offshore structures only. Erosion is still possible due to aeolian and hydrological processes or during extreme events
Dune system	None	One or more mobile ridges of blown sand of variable height (including cliffs) and often vegetated, fronted by a sand beach. Capable of overwhelming any structures to the rear. May include some wetland or saltmarsh areas
	Limited	Dune system fronted by cross or offshore structures. Erosion and movement are still possible due to aeolian and hydrological processes or during extreme events. Capable of overwhelming any structures to the rear
Coastal wetland	None	Tidally exposed vegetated areas and flats, often associated with fine-grained (muddy) sediments
	Constrained	Largely vegetated wetland areas in front of existing defences or erosion-resistant geology, prevented from migrating inland
Beach	None	Sand and coarser sediments present at high water and backed by gradually rising ground. Able to migrate both long- and cross- shore. May be vegetated
	Constrained	Sand or coarser sediments present at high water, prevented from migrating by long-shore and/or cross-shore structures. Often isolated from the natural geomorphology
Intertidal	None	Not found without a structure being present
	Constrained	Areas of mud, sand or rock exposed during low tide with a structure located around low water
Not active	Constrained	Sections of man-made structures where no coastal geomorphology exists (i.e., permanent and abrupt transition from land to water), e.g., ports and harbours
Open water	N/A	Where the defined coastline crosses a river or other water body where no coastal geomorphological feature exists

Table 2 The classification used to describe the most landward active coastal geomorphic unit, including the role of human influence



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Figure 1 Illustration of modified geomorphological types in the coastal classification

3.3 Potential broad-scale erosional linkages

In addition to local erosion effects, segments which comprise barrier features are identified as erosion could have wider consequences on flooding. Barrier features are largely mobile, composed of fine to coarse sediments, and provide natural protection against wave action to landward areas (Table 3). Any major changes in these features therefore has the potential to influence flooding impacts landward of the barrier over large cross-shore distances. In the erosion database these linkages are indicated using ‘remote’ floodplain associations.

Barrier type	Description
Spit	Stretch of beach sediment extending into the sea from the land, often comprising a combination of beach, dunes, saltmarsh and tidal flats. May be sand or coarser material
Barrier	A spit that joins two headlands, often forming a lagoon, inlet or low-lying marshy areas to landward
Tombolo	A spit that joins an island to the mainland coast
Barrier island	A ridge of mobile beach sediment, parallel to but separated from the mainland coast by a stretch of water. Usually composed of beach, dunes, saltmarsh and tidal flats

Table 3 Description of the barrier types where erosion could influence flooding on landward coasts as identified in the erosion database

3.4 Restrictive coastal structures

Based on the EuroSION dataset and interpretation of World Imagery, these are visible manmade structures, both formal and informal, that restrict the natural functioning of the coastal system. As such, in addition to seawalls, groyne fields and other coastal defence works, it also considers structures within the coastal zone whose primary purpose may not be defence but which also affect geomorphological processes. Examples include property walls, promenades, buildings, railway lines or main roads which form a continuous longshore structure. Offshore structures are recorded separately and are considered to limit geomorphological response. Where found in conjunction with other structures in the coastal zone, the latter form the primary classification. Ports and harbours and offshore structures are also identified separately (even if they are not represented in the land



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cover data set). Note that ‘soft’ engineering practices such as beach nourishment and some dune management are excluded as they are not identifiable with the available data sources.

3.5 Floodplain

The coastal floodplains used were created in CoCliCo (Lincke & Hinkel, 2023) to indicate the potentially inundated areas in a 1 in 100 year event under a 2m rise in sea level. The 1:100 year water level height (including surges) is derived from the Global Tide and Surge Reanalysis (GTSR). Using a 2m rise in sea level is in line with the recent PROTECT, CoCliCo and SCORE policy brief (PROTECT et al., 2023) which considers this magnitude of sea-level rise to be almost inevitable over the coming centuries and hence this should be addressed in planning strategies.

Coastline segments are associated with a defined floodplain both directly (local) or as part of a larger geomorphological linkage (remote). Both local and remote floodplains are identified using an ID number to allow for where there is association with multiple, disparate coastal segments. Where there are multiple remote floodplains, the two nearest are recorded.

3.6 Sediment type

The predominant sediment type can have an influence on erodibility of the coast especially important where the coastal classification is beach. Sediment type is mainly based on interpretation of visual images and EuroSION data (see Table 4 and Section 5.2). Where there is a combination of sediment types e.g., a sand beach with offshore rock platform, these are identified by primary and secondary sediment types.

Sediment type	Description
Mud	Predominantly muddy and/or fine sand sediments, may have sand as upper foreshore
Sand	Predominantly sand
Sand/Gravel	Mixture of sand and coarser grains (pebbles, gravel, shingle)
Rock	Mainly rock or rocky platform with some mobile sediments from sand to boulders. May include small beaches
No mobile sediment	No mobile geomorphology exists (i.e., permanent water presence). Applied to man-made structures and some cliffed coasts

Table 4 Description of sediment types applied in the erosion database

3.7 Shoreline movement

Shoreline movement is based analysis of shoreline position using remote sensing updated from Luijendijk *et al.* (2018). Transects are spaced at 100m intervals and the erosion database includes information from the version of 14/11/2023 which extends the analysis period from 1984 to 2021 (37 years). Movement was categorised into three trends as shown in Table 5, and applied using the



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transect nearest to each vertex in the EEA shoreline to capture as much variation in rates as possible.

Code	Historical shoreline trend	Description
Ero	Erosion	Shoreline has migrated landward at a rate greater than -0.5m/yr
Sta	Stable	Shoreline has minimal or fluctuating movement since 1984 (between -0.5 and 0.5 m/yr)
Acc	Accretion	Shoreline has migrated seaward at a rate greater than 0.5m/yr

Table 5 Qualitative shoreline trends description

3.8 Land cover

Land cover within 100m of the current coastline is taken from the Corine 2018 data set. The Corine coastal classes are grouped by how they may affect the coastal management response to future shoreline movement, by indicating the value that might be placed on the land. For example, the assumption for Groups 1 and 8 (see Table 6) is that the high land value would be to maintain protection levels, whereas Groups 6 and 7 could be allowed to evolve naturally (see Section 4). Ports and harbours not identified with the 123 Corine code are noted and included in the reclassification as code 8.



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CoCliCo code	Corine 2018 code	Code description
1. Urban fabric	111	Continuous urban fabric
	112	Discontinuous urban fabric
	121	Industrial or commercial units and public facilities
	122	Road and rail networks and associated land
	124	Mineral extraction sites
	131	Dump sites
	132	Construction sites
2. Sports and leisure	133	Green urban areas
	141	Sport and leisure facilities
3. Agriculture	142	Arable land
	211	Arable land
	212	Arable land
	213	Permanent crops
	221	Permanent crops
	222	Permanent crops
	223	Pastures
	231	Heterogeneous agricultural areas
	241	Heterogeneous agricultural areas
	242	Heterogeneous agricultural areas
	243	Heterogeneous agricultural areas
	244	Forests
4. Forests	311	Forests
	312	Forests
	313	Scrub and/or herbaceous vegetation associations
5. Open scrub areas	321	Scrub and/or herbaceous vegetation associations
	322	Scrub and/or herbaceous vegetation associations
	323	Scrub and/or herbaceous vegetation associations
	324	Open spaces with little or no vegetation
	331	Open spaces with little or no vegetation
	332	Open spaces with little or no vegetation
	333	Open spaces with little or no vegetation
	334	Open spaces with little or no vegetation
6 . Inland wetlands	411	Inland wetlands
	412	Inland wetlands
7. Maritime wetlands	421	Maritime wetlands
	422	Maritime wetlands
	423	Intertidal flats
	511	Maritime wetlands
8. Ports and harbours	123	Port areas
9. Open water	512	Inland waters
	521	Inland waters
	522	Estuary
	523	Marine waters

Table 6 Reclassification of Corine 2018 land cover codes used in the erosion database



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4 Future erosion management

Assuming that the main driver for erosion management is land value, either in social or economic terms, a limited number of potential management responses have been developed. These are shown in Table 7 and are applicable to the possible combinations of past shoreline movement, land cover and coastal classification from the erosion database with three future possible shoreline movements (erosion, accretion and stability). The responses are based on the expected consequences of future shoreline movement including an alteration in the historical trend and can be assigned to the database combinations following the steps illustrated in Figure 2 to create a look-up table (Appendix 7.3).

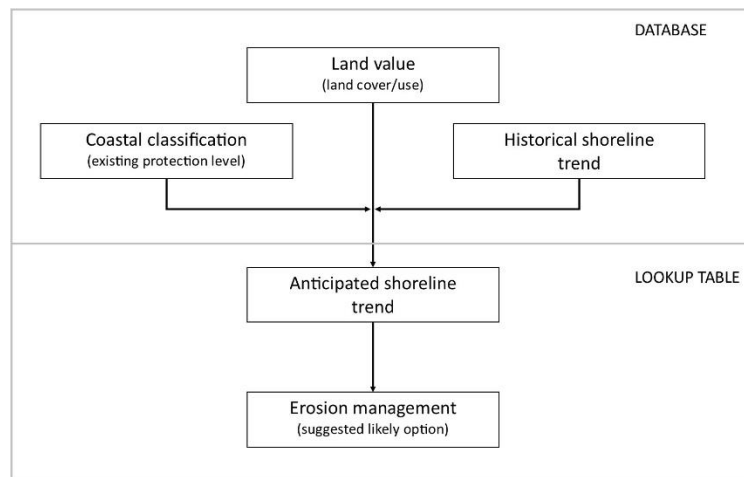


Figure 2 Flow diagram illustrating how the erosion database can be used to identify future erosion management options



STATEMENT ID	STATEMENT DESCRIPTION	EXPLANATION
1	Future recession suggests protective or retreat measures are likely to be required	The response of the natural geomorphology to waves and changing water levels exposes the land cover to the possibility of loss
2	Future accretion suggests no protective measures are likely to be required	Backshore, beach and intertidal areas will increase in width leading, naturally reducing erosion risk
3	Stabilisation of the shoreline suggests no protective measures are likely to be required	Small variations in the coastline location may occur but these are unlikely to be of concern and therefore it is unlikely that protective measures will need to be considered unless the trend changes
4	Future recession suggests existing defences may need to be adjusted or reinforced with additional measures to maintain protection levels	Existing defences are increasingly exposed to wave energy mainly through beach narrowing. To maintain levels of protection new measures will need to be undertaken
5	Future accretion suggests existing defences will maintain their effectiveness	Backshore, beach and intertidal areas will increase in width, reducing erosion risk. Existing defences may become redundant if the trend continues
6	Stabilisation suggests current defences will maintain their effectiveness	Current protective measures are sufficient to prevent erosion. Maintenance is essential
7	Protection measures unlikely to exist and will need to be implemented. Treat as unprotected	Change to erosion for a previously stable or accreting coastline means protective measures may be needed over the medium to long term as coastal land cover becomes exposed to erosion
8	No action required	A stable or accreting coastline is unlikely to need any or additional protection.
9	Future recession suggests protective or retreat measures may be required but will need to be assessed against other criteria (e.g. sustainability/environmental/biodiversity) to assess long-term viability	The type and extent of protection will need to be assessed against the type of land being lost, benefits of no action, relevant legislation, cost, local preferences etc.. Could lead to abandonment of existing defences

Table 7 Plausible management options based on present and future shoreline trends, coastal land cover and the active coastal system characteristics.



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5 Limitations of the erosion database

The erosion database has the outlined limitations as a result of both its source data and the methodology used to create it.

The EEA coastline data offers a more detailed and representative coastline for analysis than other digital coastlines but some features, especially land claim, barrier features and harbours are not always captured accurately resulting in some inaccuracies. In addition, the coastline sometimes follows features which are not visible or misinterpreted (e.g., following inland cliff lines) leading to some interpretation in the allocation of data.

The EuroSION dataset is a Europe-wide GIS database at scale 1:100,000 providing baseline information on factors influencing coastal erosion processes. However, its coverage is limited and this has restricted the scope of the information included here (see Section 5.1). European countries on the Adriatic and Black Sea coasts have not been included neither have Sweden, Norway nor Russia. The erosion database is also limited to the open coast. The nature of the dataset also required that, in addition to the assumptions listed in the following section, some inferences had to be made on the form and composition of the coast which were subjective. This included situations where determination of a cliff not included in EuroSION was erodible or erosion-resistant (use of geology and visual clues), beach composition for cliff sections where obscured by vegetation (particularly around the Baltic).

Combining the EE coastline with other data using spatial joins within GIS has led to some automatically designated values which are not always representative of the actual coastline as viewed by remote sensing. Not all of these have been identified and manually corrected. Additionally, there are inconsistencies in this initial application of the classification as proficiency and knowledge increased and new situations were encountered.

5.1 Coverage

Country	ISO Code	Applied classification	Shoreline movement trend	Land cover
Albania	AL	No	Yes	No
Belgium	BE	Yes	Yes	Yes
Bosnia and Herzegovina	BA	No	Yes	No
Bulgaria	BG	No	Yes	No



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Croatia	HR	No	Yes	No
Cyprus	CY	Partial	Yes	Partial
Denmark	DK	Yes	Yes	Yes
Estonia	EE	Yes	Yes	Yes
Finland	FI	Partial	Yes	Yes
France	FR	Yes	Yes	Yes
Germany	DE	Yes	Yes	Yes
Greece	GR	Yes	Yes	Yes
Ireland	IE	Yes	Yes	Yes
Italy	IT	Yes	Yes	Yes
Latvia	LV	Yes	Yes	Yes
Lithuania	LT	Yes	Yes	Yes
Malta	MT	Yes	Yes	Yes
Monaco	MC	Yes	Yes	Yes
Montenegro	ME	No	Yes	Yes
Netherlands	NL	Yes	Yes	Yes
Norway	NO	No	No	No
Poland	PL	Yes	Yes	Yes
Portugal	PT	Yes	Yes	Yes
Romania	RO	No	Yes	No
Russia	RU	No	Yes	No
Slovenia	SI	Yes	Yes	Yes
Spain	ES	Yes	Yes	Yes
Sweden	SE	No	No	No
Turkey	TR	No	Yes	No
Ukraine	UA	No	Yes	No
United Kingdom	UK	Yes (Scotland partial)	Yes	Yes

Table 8 List of countries with data coverage in the erosion database



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5.2 Euroasion assumptions

Code	Description	Term
Coasts		
A	Rocks and/or cliffs made of hard rocks (low level of erosion), sometimes with a rock platform	Erosion-resistant
B	Conglomerates and/or soft-rock cliffs (e.g. chalk), which are subject to erosion: presence of rock waste and sediments (sand or pebbles) on the strand	Erodible
AC	Mainly rocky, low level of erosion, with pocket beaches (<200 m long), not localised on the segment	Erosion-resistant
C	Small beaches (200 to 1000 m long) separated by rocky capes (<200m long)	Erosion-resistant
L	Coastal embankments	Intertidal constrained
Y	Artificial shoreline without sandy strands	Intertidal constrained
Sediment type		
A	Rocks and/or cliffs made of hard rocks (low level of erosion), sometimes with a rock platform	Rock
B	Conglomerates and/or soft-rock cliffs (e.g. chalk), which are subject to erosion: presence of rock waste and sediments (sand or pebbles) on the strand	Sand/Gravel
AC	Mainly rocky, low level of erosion, with pocket beaches (<200 m long), not localised on the segment	Rock
C	Small beaches (200 to 1000 m long) separated by rocky capes (<200m long)	Rock
D	Extensive beaches (>1 km long) with strands of coarse sediment (gravel or pebbles)	Sand/Gravel
E	Extensive beaches (>1 km long) with strands of fine to coarse sand	Sand
F	Coastlines of soft non-cohesive sediments (barriers, spits, tombolos)	Sand
G	Strands of muddy sediments: "wadden" and intertidal marshes with "slikkes and shorres"	Mud
J	Harbour areas	No mobile sediment
K	Artificial beaches	Not used
M	Polders	Not used
N	Very narrow and vegetated strands (pond or lakeshore type)	Sand/Gravel or Mud
P	Soft strands with rocky "platforms" (rocky flats) on intertidal strands	Rock
R	Soft strands with "beach rock" on intertidal strands	Sand/Gravel
S	Soft strands made of mine-waste sediments	Sand/Gravel
X	Soft strands of mixed grain-size categories	Sand
Z	Soft strands of unknown grain-size category	Sand/Gravel

Table 9 Euroasion assumptions for coastal and sediment type used in the database



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These assumptions were used initially to populate the EEA coastline and then amended according to the presence/absence of defences and visual interpretation of non-identified geomorphological features for the classification using Google Earth/World Imagery. In addition, EuroSION beach codes with geological code B31 (aeolian sands) are assumed to be current or past dune systems and identified accordingly unless affected by structures. This means that some of these segments may be cliffed.

5.3 Default values

In cases where the geomorphology was unclear, default values were used.

- Sediment type: Sand/Gravel
- Geomorphology: Beach
- Defence: N

This mainly occurred where there was a lack of EuroSION data and clarification from visual images was not possible due to pixelation (sensitive areas) or where there is no structure but the geomorphology is obscured due to vegetation cover or agricultural use close to the coastline.

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7 APPENDICES

7.1 Appendix 1 Data sources

The erosion database is constructed by integrating available data (downloaded in 2023) and CoCliCo project outputs as shown in Table 10.

Use	Source	Link
Coastline	EEA coastline for analysis	https://www.eea.europa.eu/data-and-maps/data/eea-coastline-for-analysis-2/gis-data/eea-coastline-polyline
Geology and Geomorphology	EEA/EuroSION	https://www.eea.europa.eu/data-and-maps/figures/geology-and-geomorphology
Land cover/use	Corine 2018	https://land.copernicus.eu/en/products/corine-land-cover
Elevation	CoCliCo floodplain Google Earth	As defined in (Section 3.5) https://www.google.co.uk/intl/en_uk/earth/
Shoreline movement	CoCliCo analysis	Based on https://aqua-monitor.appspot.com/?datasets=shoreline
Coastal structures	EuroSION World Imagery/Google Earth	As above https://earth.google.com/

Table 10 Data sources used in the generation of the coastal classification and erosion database



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7.2 Appendix 2 Attribute list

Name	Description	Unit
Source		
Country	ISO 2 letter country code	
Covered	Indicates the classification has been applied to the coastal segment	Yes/No
SEG_ID	Country level segment identification	
SEG_Length	Segment length	m
Floodplain	Association with either local or remote floodplains	Y/N
L_FP	ID number of local flood plain	No.
L_FP_Area	Area of local floodplain	m ²
R_FP_1	ID number of remote floodplain_1	No.
R_FP_2	ID number of remote floodplain_2	No.
Onshore_Structure	Structure in the coastal zone that affects coastal evolution	Y/N
Offshore_Structure	Offshore structure that affects coastal evolution	Y/N
Harbour	Presence of a port or harbour	Y/N
Active_geo	Classification of the active coastal system	
Barrier	Description of barrier type where present	
Sed_type_1	Description of primary sediment type	
Sed_type_2	Description of secondary sediment type	
Hist_Trend	Descriptive historical shoreline movement trend	(Ero /Acc /Sta)
Code_18	Corine 2018 land cover code	
Recl_18	CoCliCo reclassification of Corine 2018 land cover codes	

Table 11 List of segment attributes included in the erosion database



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7.3 Appendix 3 Erosion management lookup table

			COASTAL GEOMORPHOLOGICAL CLASS								
LANDUSE CLASS	HISTORICAL TREND	FUTURE TREND	Erodible cliffs	Erodible cliff limited	Dune system	Dune system limited	Coastal wetland	Coastal wetland constrained	Beach	Beach constrained	Intertidal constrained
1. Urban fabric	Erosion	Erosion	1	4	1	4	1	4	1	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	1	7	1	7	1	7	1	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	1	7	1	7	1	7	1	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
2. Sports and leisure	Erosion	Erosion	1	4	1	4	1	4	1	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	1	7	1	7	1	7	1	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	1	7	1	7	1	7	1	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
3. Agriculture	Erosion	Erosion	9	4	9	4	9	4	9	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6



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4. Forests	Erosion	Erosion	9	4	9	4	9	4	9	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
5. Open, scrub, areas	Erosion	Erosion	9	4	9	4	9	4	9	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
6. Inland wetland	Erosion	Erosion	9	4	9	4	9	4	9	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
7. Coastal wetland	Erosion	Erosion	9	4	9	4	9	4	9	4	4
		Accretion	2	5	2	5	2	5	2	5	5
		Stable	3	6	3	6	3	6	3	6	6
	Accretion	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6
	Stable	Erosion	9	7	9	7	9	7	9	7	4
		Accretion	2	8	2	8	2	8	2	8	5
		Stable	3	8	3	8	3	8	3	8	6



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8. Ports and harbours		N/A. Presumption that these will be maintained in their current condition irrespective of shoreline change
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Table 12 Look-up table: suggested most likely future erosion management for combinations of shoreline movement, land cover and geomorphological class



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