Supplementary material

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Abbreviations

SDS	Satellite-Derived Shorelines
SLR	Sea-Level Rise
DEM	Digital Elevation Model
std	Standard Deviation
NWHS	Natural World Heritage Sites
GLCNMO	Global Land Cover by National Mapping Organizations
GLiM	Global Lithological Map
OLS	Ordinary Least Square
SCR	Shoreline Change Rate
ev	Evaporites
ig	Polar ice and Glaciers
pa	Acid Plutonic Rocks
pb	Basic-Ultrabasic Plutonic Rocks
pi	Intermediate Plutonic Rocks
mt	Metamorphic Rocks
sc	Carbonate Sedimentary Rocks
sm	Mixed Sedimentary Rocks
ss	Siliciclastic Sedimentary Rocks
su	Unconsolidated Sediments
py	Pyroclastic
va	Acid Volcanic Rocks
vb	Basic Volcanic Rocks
vi	Intermediate Volcanic Rocks
nd	No Data

A.1 Data

A.1.1 Shoreline change time-series

1 482 203 time-series data points were selected using the boundaries of the 88 coastal NWHS with a 1 km buffer to capture the SDS data points at the edge of the site and to account for errors in the boundaries' generation due to the lack of capacity for mapping, surveying, and digitising the protected areas accurately[1].

The flowchart of the conditional cleaning and outliers cleaning performed on the shoreline change time-series data are available in Figure SM1. First, a conditional cleaning based on the minimum number of SDS points and a temporal coverage for each transect was performed. A range of minimal numbers of yearly SDS points were tested such as 10, 17 (~half of the total data time-scale coverage of 33 years), 20, and 30 years (leading consecutively to the removal of 0.53%, 2.15%, 7.32% and 47.5% of the data). All transects that have at least 17 SDS data points were maintained which induces the removal of less than 5% of the data (maximum value to be dropped when handling outliers[2,3]). The minimal SDS temporal coverage required for each transect is 7 years which is equivalent to half the lowest time coverage for which satellite images are available for some oceanic islands (14 years starting from 2002) [4]. After the first cleaning, a visual verification of shoreline change for each transect demonstrated the presence of outliers that may originate from the accuracy of (1) automated shoreline detection derived from satellite imagery; and (2) the Ordinary Least Squares method used to quantify the change from the satellite-derived shorelines[5] (Figure SM2). For each transect, SDS points deviating by more than three times the standard deviation (std) were dropped. By using three standard deviations, the yearly deviating SDS, excluded from the analysis, are far enough from the mean trend to consider that they are not storm influenced data. Moreover, previous studies on coastal reaches where storms play a minor role in shaping the coastlines showed that storm-influenced event does not increase substantially the range of uncertainties surrounding long-term shoreline assessment[6]. For the remaining SDS data points, another cleaning (minimum time coverage of 7 years and minimum SDS data point of 17) was performed. The conditional cleaning (based on the number of SDS data points and time coverage for each transect) and the removal of outliers led to the removal of 3.83% of the raw dataset. Each SDS data point, derived from moving average composite images, has a subpixel precision with a confidence interval of [-15, 15 m] for Landsat images.

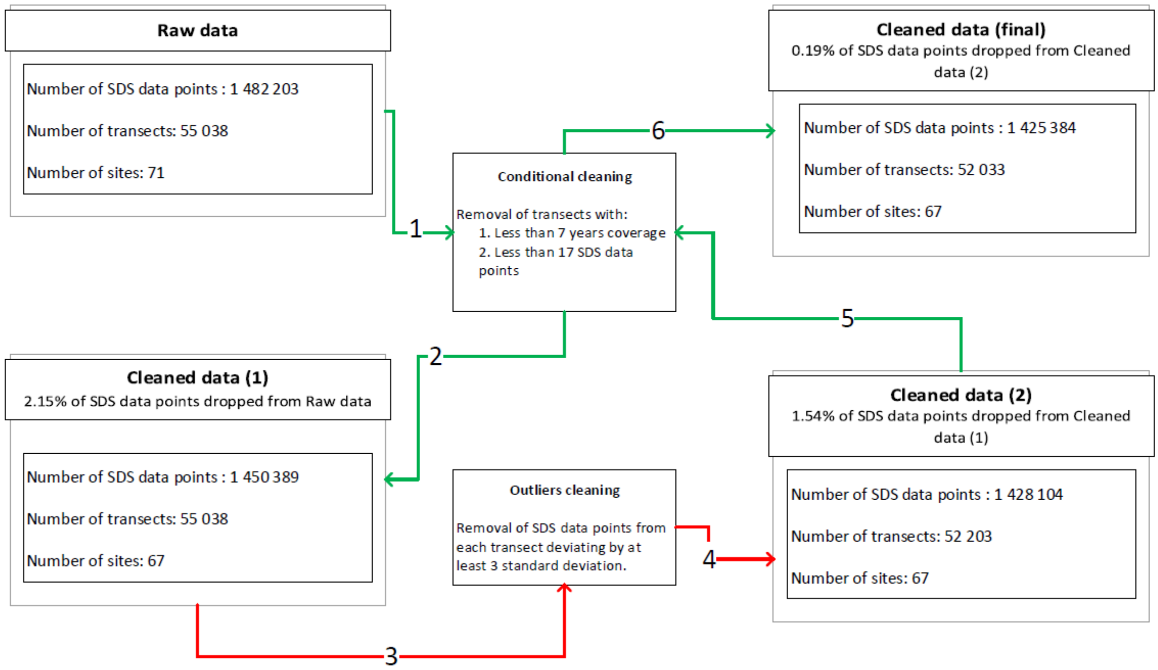
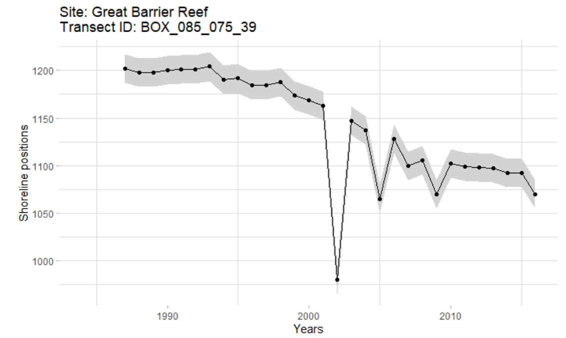


Figure SM1 Flowchart of the conditional cleaning and outliers cleaning performed on the SDS time-series data. The conditional cleaning (green lines) is performed for more consistency on the assessment of shoreline trends in term of time-coverage and number of data-points. The outliers cleaning (red lines) is performed to delete extreme SDS data points values within each transect. The numbers from 1 to 6 depict the order in which the cleaning operations were made.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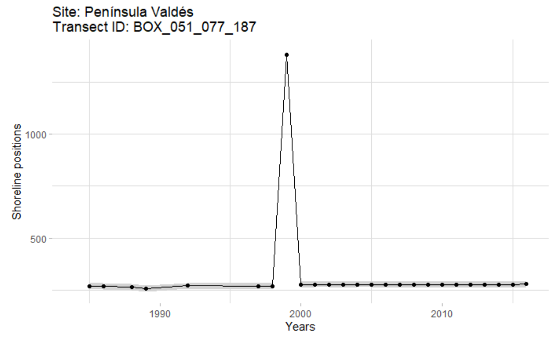
Transect ID: BOX_085_075_39
Shoreline positions
Years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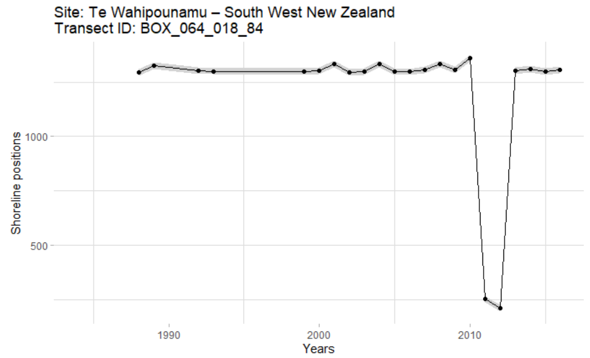
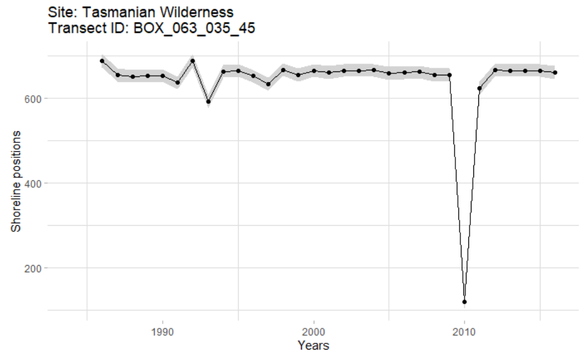
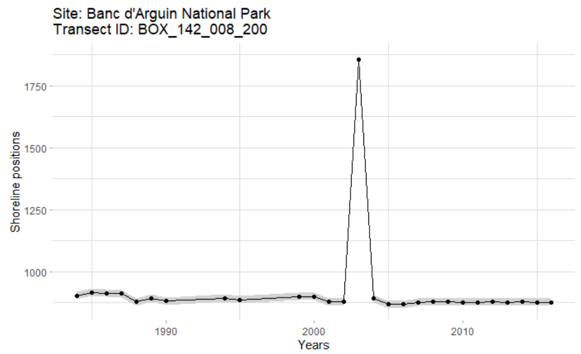
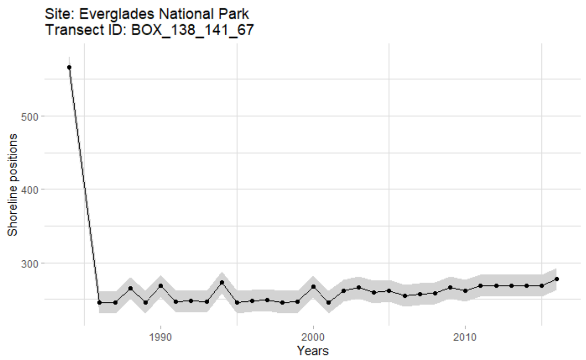
Shoreline positions
Years


Site: Te Wahipounamu – South West New Zealand
Transect ID: BOX_064_018_84
Shoreline positions
Years


Site: Tasmanian Wilderness
Transect ID: BOX_063_035_45
Shoreline positions
Years


Site: Banc d'Arguin National Park
Transect ID: BOX_142_008_200
Shoreline positions
Years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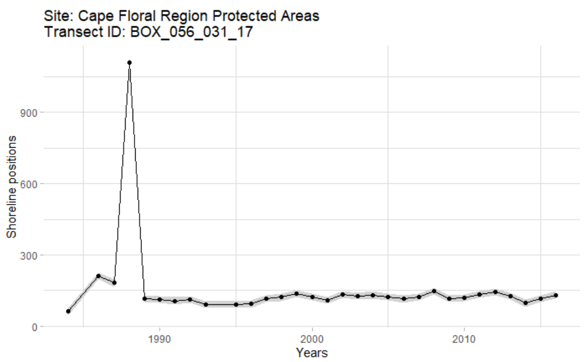
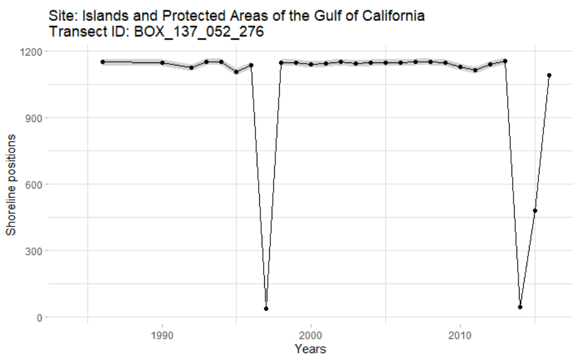
Transect ID: BOX_138_141_67
Shoreline positions
Years


Site: Cape Floral Region Protected Areas
Transect ID: BOX_056_031_17
Shoreline positions
Years


Site: Islands and Protected Areas of the Gulf of California
Transect ID: BOX_137_052_276
Shoreline positions
Years

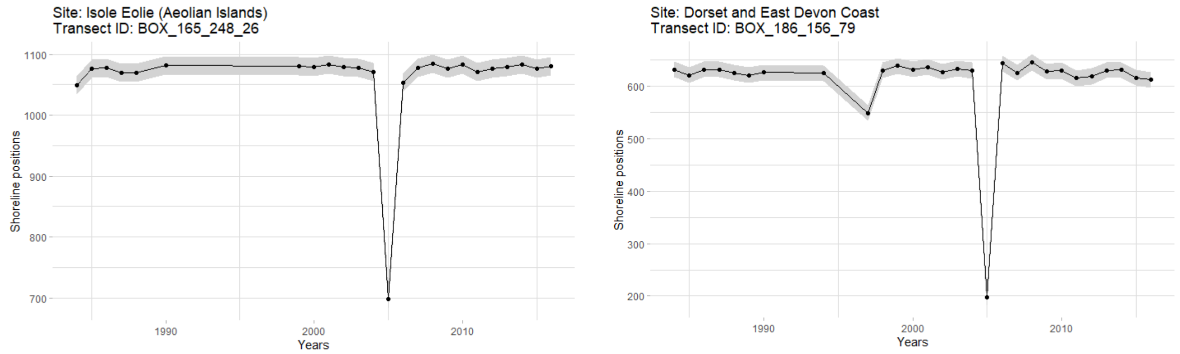
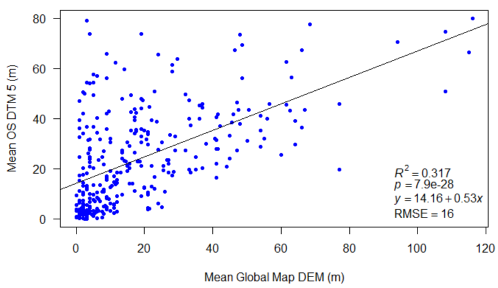
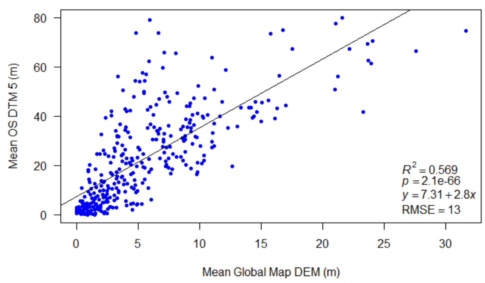


Figure SM2 Examples of outliers deviating from the general trend of SDS data points within individual transects from 1984 to 2016.

A.1.2 Geomorphological conditions

Elevation data were used to classify the sites' transects in term of the topographic variation of a buffer zone around each transect, to allow the differentiation between transects in low-lying areas or highlands. Following a comparison between different elevation-extraction approaches (Figure SM3), the extraction methodology using the mean value of Global Map DEM elevations within a buffer of 500 m around the "1984 intersection point" (transect intersection with the shoreline in 1984 or the earliest shoreline available) was adopted for all the study area transects. Among 52 033 transects, 1 121 transects had missing values in term of their mean elevation. The DEM data were heavy-tailed distributed[7,8], thus, the elevation categories were defined by arithmetic means calculated until the remaining data (head part) are not heavy-tailed. As the geomorphological analysis was applied to transects with strong linear shoreline behaviours, first, two categories were defined by the mean of the elevation data for transects with stong linear behaviour (11.05 rounded to 10 m). The first cluster [0 to 10 m] was divided into 2 sub-clusters: extremely low-elevations [0; 1 m] and low elevations]1 to 10 m]. The mean value of elevation of the second cluster (47.35 m rounded to 50 m) was used to divide it into two sub-clusters:]10 to 50 m] and]50 to 400 m[to account for middle- and high-elevations.

	Raster to Point	Raster to polygon
Buffer radius 250 m		

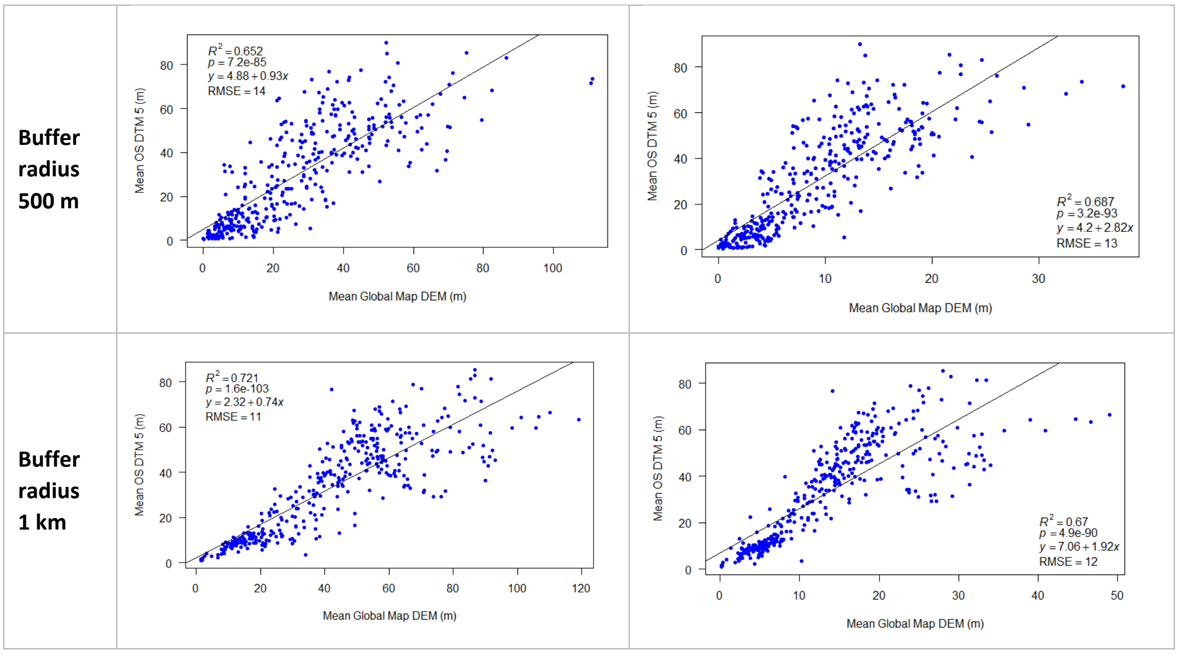


Figure SM3 Comparison of the effect of raster transformation on the coarse Global Map DEM (raster to point, raster to polygon) on the mean value of elevation for three buffer radius: 250 m, 500 m and 1 km.

The nature of, and change in coastal land cover, driven by natural variability or/and intensive human activities, is a potential factor of erosion[9,10]. The Global Land Cover by National Mapping Organizations - GLCNMO (2013) at 15 arc-seconds resolution was adopted due to its high overall consistency in comparison to other land cover datasets (~500 m at the equator). The land covers of the globe were classified into 20 categories which were assembled into 6 categories (Table SM1): (1) coral reefs, (2) mangroves, (3) marches, (4) vegetated, (5) non-vegetated and (6) urban[11]. In this paper, coral reefs, mangroves and marshes were prioritised to evaluate their coastal protection in comparison to vegetated, non-vegetated or urban areas within coastal NWHS.

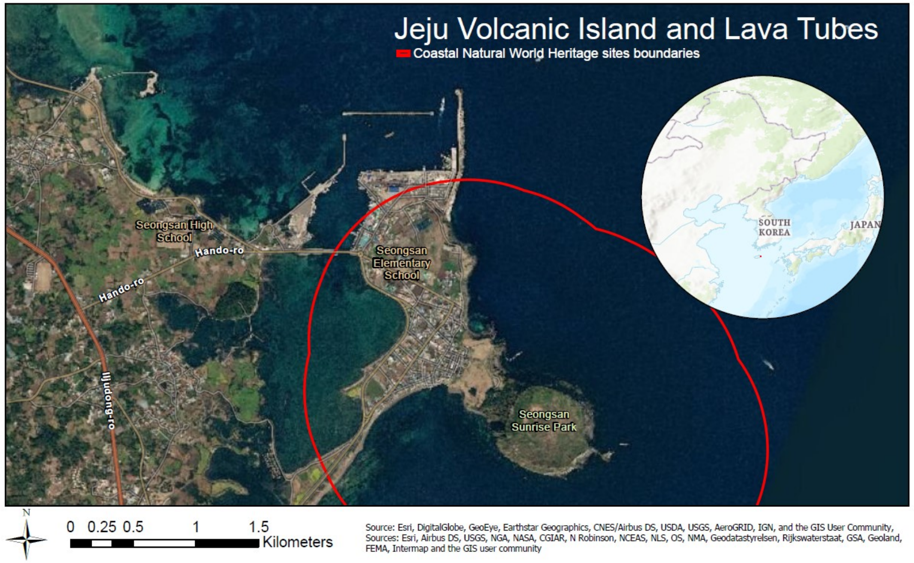
Table SM1 Definition of the six land cover categories. For each transect represented by "1984 intersection point", the classification parameters defined how the categorical value of land cover has been allocated.

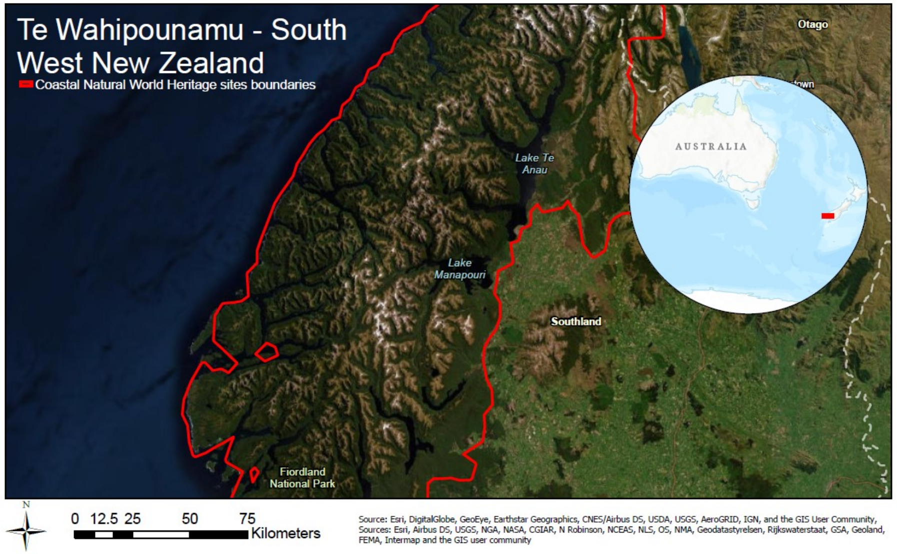
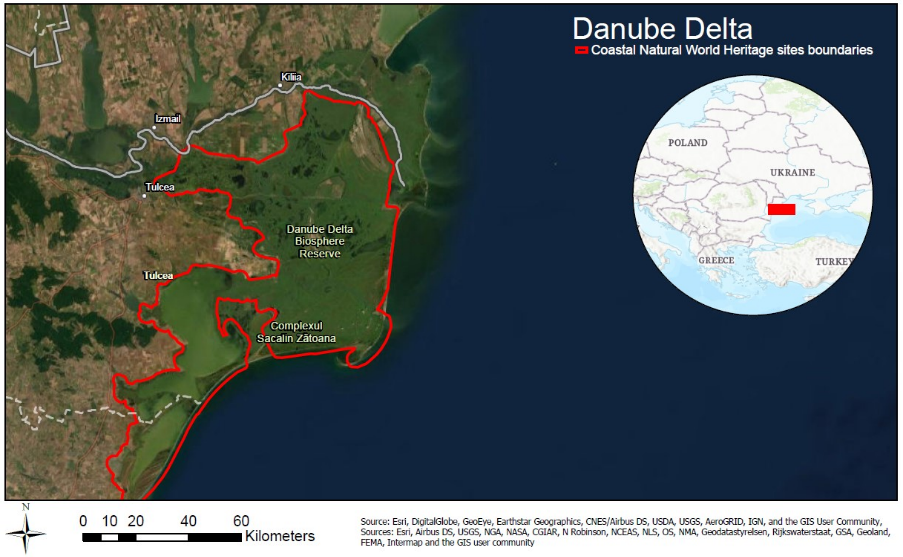
Category	Categorisation parameters
1. Coral reefs	Within 1 km geodesic distance from the polygons of Global Distribution of Coral Reefs data and intersect all GLCNMO categories
2. Mangroves	Intersect GLCNMO category 14 or within 1 km geodesic distance from the polygons of the Global Distribution of Mangroves data
3. Marshes	Intersect GLCNMO category 15
4. Vegetated	Intersect GLCNMO categories 1 to 13
5. Non-vegetated	Intersect GLCNMO categories >=16 and different from 18
6. Urban	Intersect GLCNMO class 18

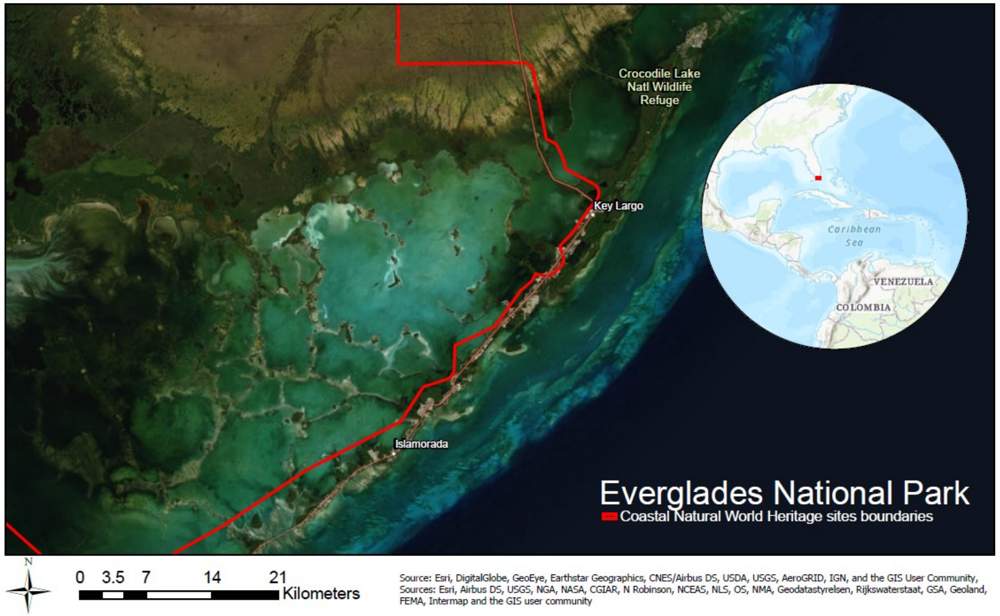
A global dataset of nearshore coastal types that account for the hydrology, lithology and morphology of coastal areas was used[12]. These parameters play a role on coastal changes affected by SLR, storms, or cyclones[12,13]. According to the STN-30 drainage basin and river network[14], the data describe the interface between continents and the open water by using seven coastal types from which four are estuarine filter types: I-small deltas, II-tidal systems, III-lagoons, IV-fjords and fjärds, V-a-large rivers, V-b-large rivers with tidal deltas, VI-karst-dominated stretches of coasts and VII-arheic (dry areas). This classification does not consider the seasonal variability and describes long-term action of incoming riverine material (~10th of years) which is in accordance with the multi-decadal shoreline change time-series data used in this study. First, to validate the coastal type dataset, the coastal type for the study area were verified visually using ArcGIS through the observation of features describing the coastal type for each site (Table SM2). For islands with no data available, a new category named “VIII-islands” was added to the classification.

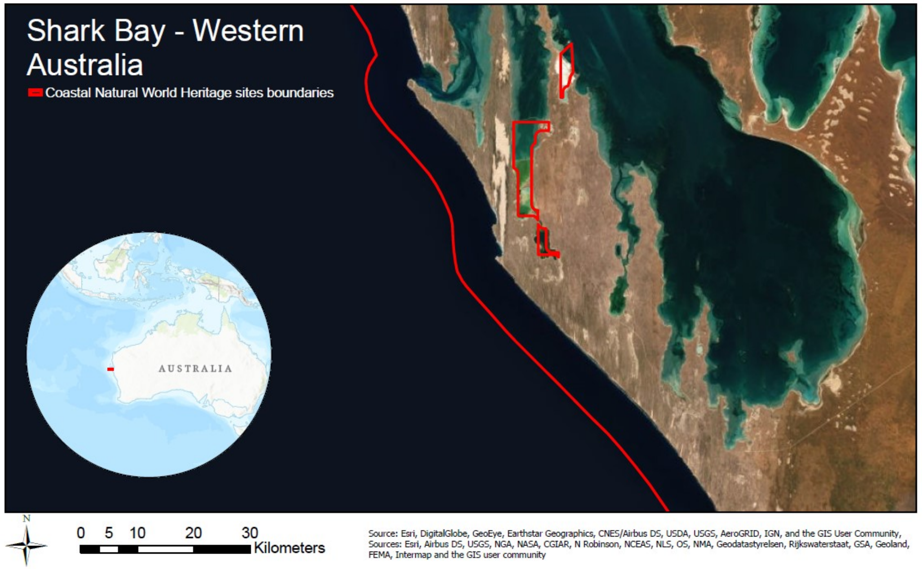
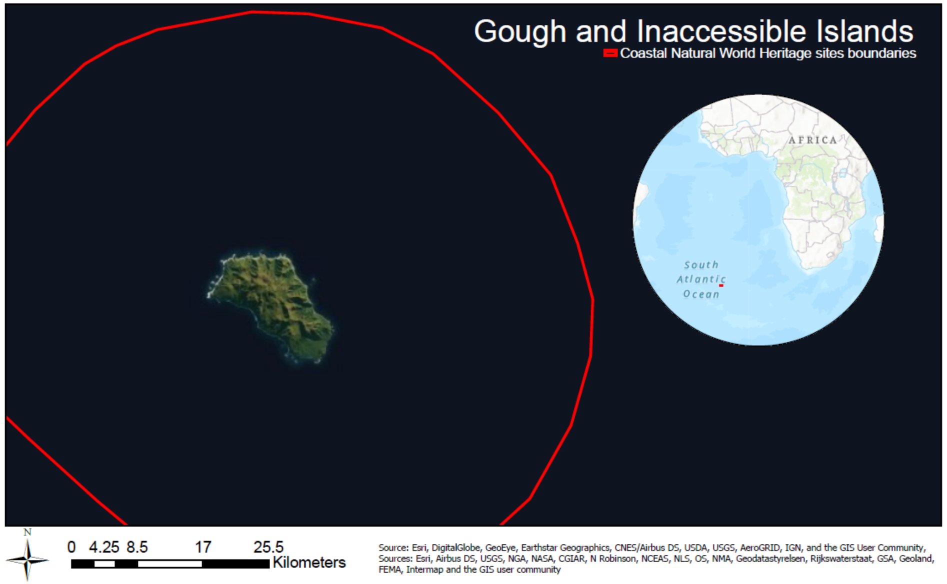
Table SM2 Description of coastal types and visual verification of the transect-based allocation of each coastal type within the 88 coastal NWHS. The coastal types and their descriptions are adapted from the global dataset of nearshore coastal types developed by Dürr *et al.* , 2011[12]. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

Coastal type	Description	Examples
I-small deltas	Small deltas are landforms created by the deposition of sediment at the point where a river enters the oceans or seas. A small delta can be wave-, tide-, or river-dominated. This category applies to small deltas in comparison to large well-known deltas that are mapped in the "large rivers" category. **Number of sites:** 27 sites	
II-tidal systems	Tidal systems are water areas of rivers that are influenced by tides such as rias, tidal embayment and funnel-shaped estuaries. **Number of sites:** 13 sites	

		
III-lagoons	Lagoons are defined as shallow water body separated from the open ocean by sandbars, barrier reefs, coral reefs or other natural barriers with minimal tidal influence. **Number of sites:** 11 sites	

<table>
<tr>
<td>IV-fjords and fjärds</td>
<td>Fjords are U-shaped elongated, deep and narrow sea inlet formed by glaciers. They are generally surrounded by 3 steep cliffs.
Fjärds are glacially formed valleys that are wider, shallower and have gentle slopes in comparison to fjords.
Number of sites: 10 sites</td>
<td>
</td>
</tr>
<tr>
<td>V-large rivers</td>
<td>Large rivers are coastal areas within river-dominated ocean margins where rivers input fluxes have a significant impact on the ocean in term of freshwater, sediment or dissolved and particulate materials (V-a-large rivers).
A secondary type within large rivers is defined when the river mouth is situated with tidal deltas (V-b-large rivers with tidal deltas)
Number of sites: 2 sites
Observations: Colorado river (V-b) and Danube river (V-a)</td>
<td>
</td>
</tr>
</table>

VI-karst-dominated stretches of coasts	Karst-dominated stretches of coasts are landforms that are dominated by carbonate rock dissolution and with an important groundwater discharge. **Number of sites:** 3 sites **Observations:** Karst wetland of the Everglades National Park, Ha Long Bay karst plain, and Karst landscape in the Northern Velebit National Park (part of the Primeval Beech Forest of the Carpathians and Other Regions of Europe)	

VII-arheic coast	Arheic coasts are arid and desert coasts where there is a near-total absence of water inputs. **Number of sites:** 5 sites		
VIII-islands	Islands are sites surrounded by water, which are not described within the coastal typology dataset. **Number of sites:** 18 sites		

The lithology (rock type) is one of the numerous factors that impact coastal landforms and morphology [15] and thus coastal erosion and shoreline change. A coast made of a resistant type of rock (granite, sandstone) will respond differently to forcing drivers than a coast made of unconsolidated sediments (sand, clay). For instance, dominant cliff-forming lithology has been coupled to cliff geometry and trends of long term erosion rates to predict regional coastal cliff retreat[16]. The Global Lithological Map (GLiM) is the most accurate dataset describing the properties of surface rocks worldwide. The dataset has an average resolution of 1:3 750 000 and is composed of 1.2 million polygons with different shapes available for all Earth terrestrial land[17]. The 16 lithological categories defined by GLiM were used except the water body category. For each transect, the nearest geodesic lithological value was allocated to the “1984 intersection point”. For all the study area transects, the lithological composition is available (no missing data).

Table SM3 Coastal types within each of the 67 coastal NWHS.

Name	Coastal type
Alejandro de Humboldt National Park	Small deltas
Area de Conservación Guanacaste	Small deltas
Atlantic Forest Southeast Reserves	Lagoons
Banc d'Arguin National Park	Small deltas
Banc d'Arguin National Park	Arheic
Belize Barrier Reef Reserve System	Lagoons
Cape Floral Region Protected Areas	Small deltas
Central Sikhote-Alin	Small deltas
Coiba National Park and its Special Zone of Marine Protection	Islands
Danube Delta	Lagoons
Danube Delta	Large rivers
Darien National Park	Small deltas
Desembarco del Granma National Park	Small deltas
Discovery Coast Atlantic Forest Reserves	Tidal systems
Doñana National Park	Small deltas
Dorset and East Devon Coast	Tidal systems
Everglades National Park	Lagoons
Everglades National Park	Karst
Fraser Island	Small deltas
Galápagos Islands	Small deltas
Giant's Causeway and Causeway Coast	Fjords and fjärds
Great Barrier Reef	Small deltas
Great Barrier Reef	Tidal systems
Gros Morne National Park	Fjords and fjärds
Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve	Small deltas
Ha Long Bay	Karst
Hawaii Volcanoes National Park	Small deltas
High Coast / Kvarken Archipelago	Fjords and fjärds
High Coast / Kvarken Archipelago	Islands
Ibiza, Biodiversity and Culture	Islands

iSimangaliso Wetland Park	Lagoons
Islands and Protected Areas of the Gulf of California	Small deltas
Islands and Protected Areas of the Gulf of California	Lagoons
Islands and Protected Areas of the Gulf of California	Arheic
Islands and Protected Areas of the Gulf of California	Islands
Islands and Protected Areas of the Gulf of California	Large rivers (tidal)
Isole Eolie (Aeolian Islands)	Islands
Jeju Volcanic Island and Lava Tubes	Lagoons
Joggins Fossil Cliffs	Tidal systems
Kakadu National Park	Tidal systems
Komodo National Park	Small deltas
Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems	Tidal systems
Laurisilva of Madeira	Islands
Lorentz National Park	Tidal systems
Miguasha National Park	Fjords and fjärds
Mistaken Point	Fjords and fjärds
Mount Athos	Islands
Namib Sand Sea	Small deltas
New Zealand Sub-Antarctic Islands	Islands
Ningaloo Coast	Small deltas
Olympic National Park	Fjords and fjärds
Península Valdés	Small deltas
Pitons Management Area	Islands
Primeval Beech Forests of the Carpathians and Other Regions of Europe	Islands
Puerto-Princesa Subterranean River National Park	Small deltas
Rainforests of the Atsinanana	Lagoons
Redwood National and State Parks	Small deltas
Río Plátano Biosphere Reserve	Lagoons
Rock Islands Southern Lagoon	Islands
Sanganeb Marine National Park and Dungonab Bay - Mukkawar Island Marine National Park	Islands
Shark Bay, Western Australia	Small deltas
Shark Bay, Western Australia	Arheic
Shiretoko	Small deltas
Sian Ka'an	Lagoons
Socotra Archipelago	Islands
Sundarbans National Park	Tidal systems
Tasmanian Wilderness	Tidal systems
Te Wahipounamu – South West New Zealand	Small deltas
Te Wahipounamu – South West New Zealand	Fjords and fjärds
The Sundarbans	Tidal systems
The Wadden Sea	Tidal systems
Tropical Rainforest Heritage of Sumatra	Small deltas
Ujung Kulon National Park	Small deltas
Volcanoes of Kamchatka	Small deltas

Volcanoes of Kamchatka	Lagoons
West Norwegian Fjords – Geirangerfjord and Nærøyfjord	Fjords and fjärds
Wet Tropics of Queensland	Small deltas
Whale Sanctuary of El Vizcaino	Arheic
Yakushima	Islands

A.2 Results

A.2.1 Shoreline change time-series

Table SM4 Number and percentages of transects within the classification categories of shoreline change time-series. The percentage is relative to the totality of transects.

	Total		**Negative correlation (r≤0)**		**Positive correlation (r≥0)**	
Pearson's r classification	Number of transects	Percentage of transects (%)	Number of transects	Percentage of transects (%)	Number of transects	Percentage of transects (%)
Strong Linear	7 087	14%	3 908	8%	3 179	6%
Weak linear	21 449	41%	11 134	21%	10 315	20%
Non-linear	23 497	45%	11 950	23%	11 547	22%

Table SM5 Percentage of transects with strong linear, weak linear and non-linear behaviours within the 67 coastal NWHS. The sites are classified in descending order of the percentage of transects with a strong linear behaviour.

Sites	**Total number of transects**	**Percentage of transects (%)**		
		Strong linear	**Weak linear**	**Non-linear**
The Sundarbans	1 006	63.5	21.4	15.1
Danube Delta	351	57.3	28.5	14.2
Sundarbans National Park	1209	48.9	32.3	18.8
Ningaloo Coast	649	40.5	39.1	20.3
Banc d'Arguin National Park	2550	28.6	30.7	40.7
Shark Bay, Western Australia	821	28.6	50.7	20.7
Kakadu National Park	608	24.3	39	36.7
Discovery Coast Atlantic Forest Reserves	48	22.9	56.2	20.8
Galápagos Islands	612	18	52	30.1
Fraser Island	1384	17.7	52.7	29.6
Great Barrier Reef	9174	16.8	44.7	38.5
Islands and Protected Areas of the Gulf of California	900	14	45.9	40.1
Whale Sanctuary of El Vizcaino	4641	14	59.8	26.2
Wet Tropics of Queensland	22	13.6	50	36.4
Tropical Rainforest Heritage of Sumatra	158	13.3	38.6	48.1
Namib Sand Sea	719	13.1	35.5	51.5
Jeju Volcanic Island and Lava Tubes	16	12.5	37.5	50
Shiretoko	229	12.2	72.9	14.8
Lorentz National Park	267	11.6	36.7	51.7
Río Plátano Biosphere Reserve	78	11.5	66.7	21.8

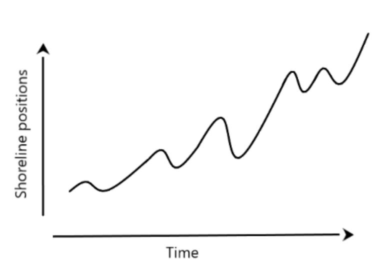
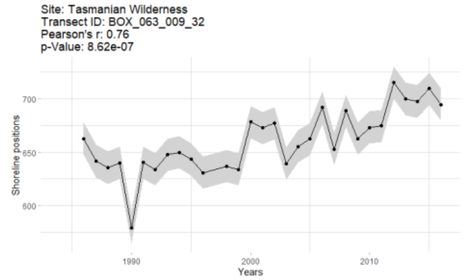
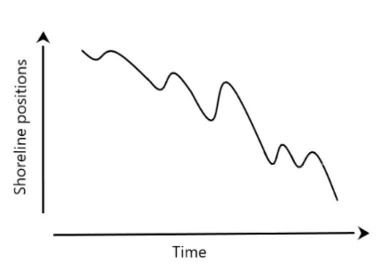
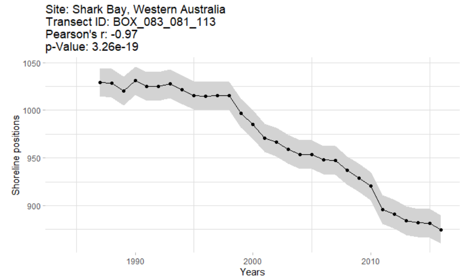
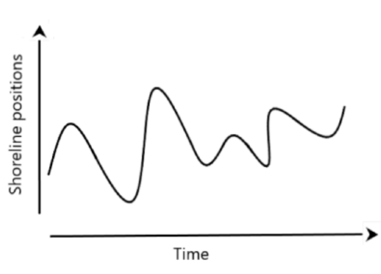
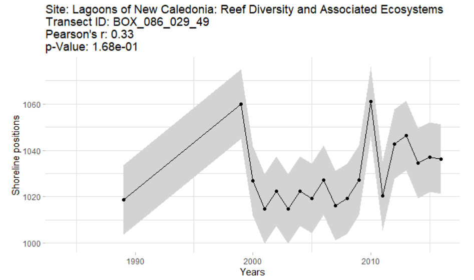
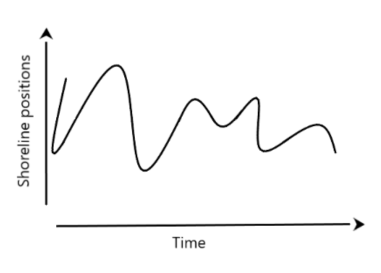
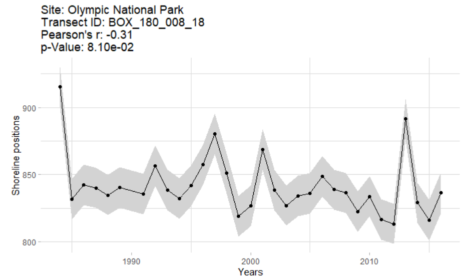
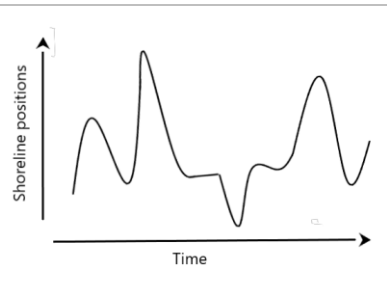
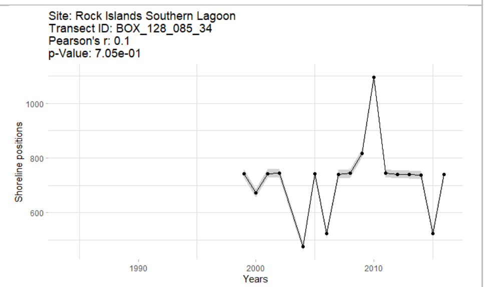
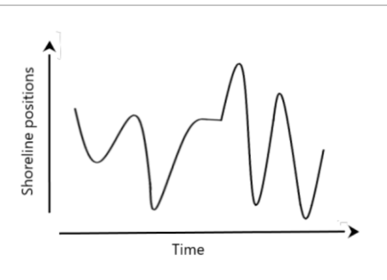
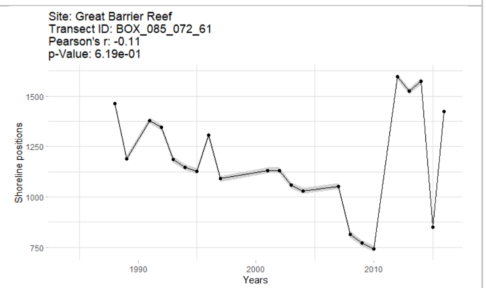
Tasmanian Wilderness	1091	10.8	46.6	42.6
The Wadden Sea	5015	9.9	35.1	55
Atlantic Forest Southeast Reserves	764	9.7	37.8	52.5
Everglades National Park	1274	9	41.4	49.6
High Coast / Kvarken Archipelago	3346	8.8	43	48.2
Ujung Kulon National Park	374	7.2	38	54.8
Redwood National and State Parks	142	7	34.5	58.5
Miguasha National Park	15	6.7	73.3	20
Doñana National Park	67	4.5	53.7	41.8
Rainforests of the Atsinanana	27	3.7	59.3	37
Joggins Fossil Cliffs	85	3.5	40	56.5
Cape Floral Region Protected Areas	788	3	39.2	57.7
Volcanoes of Kamchatka	1364	3	43.9	53.1
Alejandro de Humboldt National Park	35	2.9	31.4	65.7
Te Wahipounamu – South West New Zealand	3185	2.8	38.9	58.2
Area de Conservación Guanacaste	167	2.4	65.9	31.7
Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve	1143	2.4	42.8	54.9
Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems	427	2.3	27.7	69.9
Gros Morne National Park	346	2.3	54.5	43.2
iSimangaliso Wetland Park	132	2.3	20.4	77.3
Sanganeb Marine National Park and Dungonab Bay - Mukkawar Island Marine National Park	469	1.9	53.9	44.1
Komodo National Park	647	1.7	27.4	70.9
Desembarco del Granma National Park	131	1.5	56.5	42
Península Valdés	994	1.3	46.1	52.6
West Norwegian Fjords – Geirangerfjord and Nærøyfjord	623	1.1	23.8	75.1
Sian Ka'an	756	1.1	34.3	64.5
Socotra Archipelago	736	1	38.9	60.2
Rock Islands Southern Lagoon	186	0.5	33.5	66
Central Sikhote-Alin	191	0.5	33.8	65.7
Isole Eolie (Aeolian Islands)	216	0.5	25.3	74.2
Coiba National Park and its Special Zone of Marine Protection	302	0.3	30.5	69.2
Dorset and East Devon Coast	407	0.2	26.5	73.2
Belize Barrier Reef Reserve System	113	0	22.1	77.9
Darien National Park	30	0	16.7	83.3
Giant's Causeway and Causeway Coast	18	0	0	100
Ha Long Bay	148	0	32.4	67.6
Hawaii Volcanoes National Park	24	0	50	50
Ibiza, Biodiversity and Culture	88	0	48.9	51.1
Laurisilva of Madeira	43	0	2.3	97.7
Mistaken Point	49	0	26.5	73.5
Mount Athos	272	0	20.6	79.4
New Zealand Sub-Antarctic Islands	26	0	11.5	88.5
Olympic National Park	257	0	52.5	47.5

Pitons Management Area	18	0	38.9	61.1
Primeval Beech Forests of the Carpathians and Other Regions of Europe	24	0	4.2	95.8
Puerto-Princesa Subterranean River National Park	12	0	16.7	83.3
Yakushima	24	0	50	50

Table SM6 Comparison between the contributions of transects with strong linear, non-linear and weak linear shoreline trends in the recessional, depositional and stable shoreline trends (under the hypothesis of long-term shoreline change and that linear fit is better to describe and forecast long-term shoreline change behaviour[18]). It is acknowledged that the rates calculated for weak linear and non-linear shoreline behaviours are indicatives and not accurate (use of OLS linear regression for non-linear/weak linear behaviours). The highest mean values of recessional and depositional shoreline trends are highlighted in yellow. This assessment is performed with the removal of outliers defined by the SCR of the linear behaviour.

	Recessional change ($m\ yr^{-1}$)			**Depositional change ($m\ yr^{-1}$)**			**Stable ($m\ yr^{-1}$)**		
Transects' shoreline trend	% of transects	Mean	Std	% of transects	Mean	Std	% of transects	Mean	Std
Strong Linear	7.1	-3.4	3.6	5.8	3.5	4.3	0.6	0	0.4
Non-linear	7.9	-2.3	2.3	6.7	2.1	2.2	30.8	0	0.2
Weak Linear	15.3	-2.9	3.6	13.5	2.7	3.5	12.4	0	0.3

Table SM7 Descriptions and examples of strong linear, weak linear and non-linear shoreline behaviours based on Pearson's r correlation coefficient.

Type	Description	Graphical description	Example
Strong linear (positive correlation)	Pearson's correlation $r \geq 0.7$		
Strong linear (negative correlation)	Pearson's correlation $r \leq -0.7$		
Weak linear (positive correlation)	Pearson's correlation $0.3 < r < 0.7$		
Weak linear (negative correlation)	Pearson's correlation $-0.7 < r < -0.3$		
Non-linear (positive correlation)	Pearson's correlation $r \leq 0.3$		
Non-linear (negative correlation)	Pearson's correlation $r \geq -0.3$		

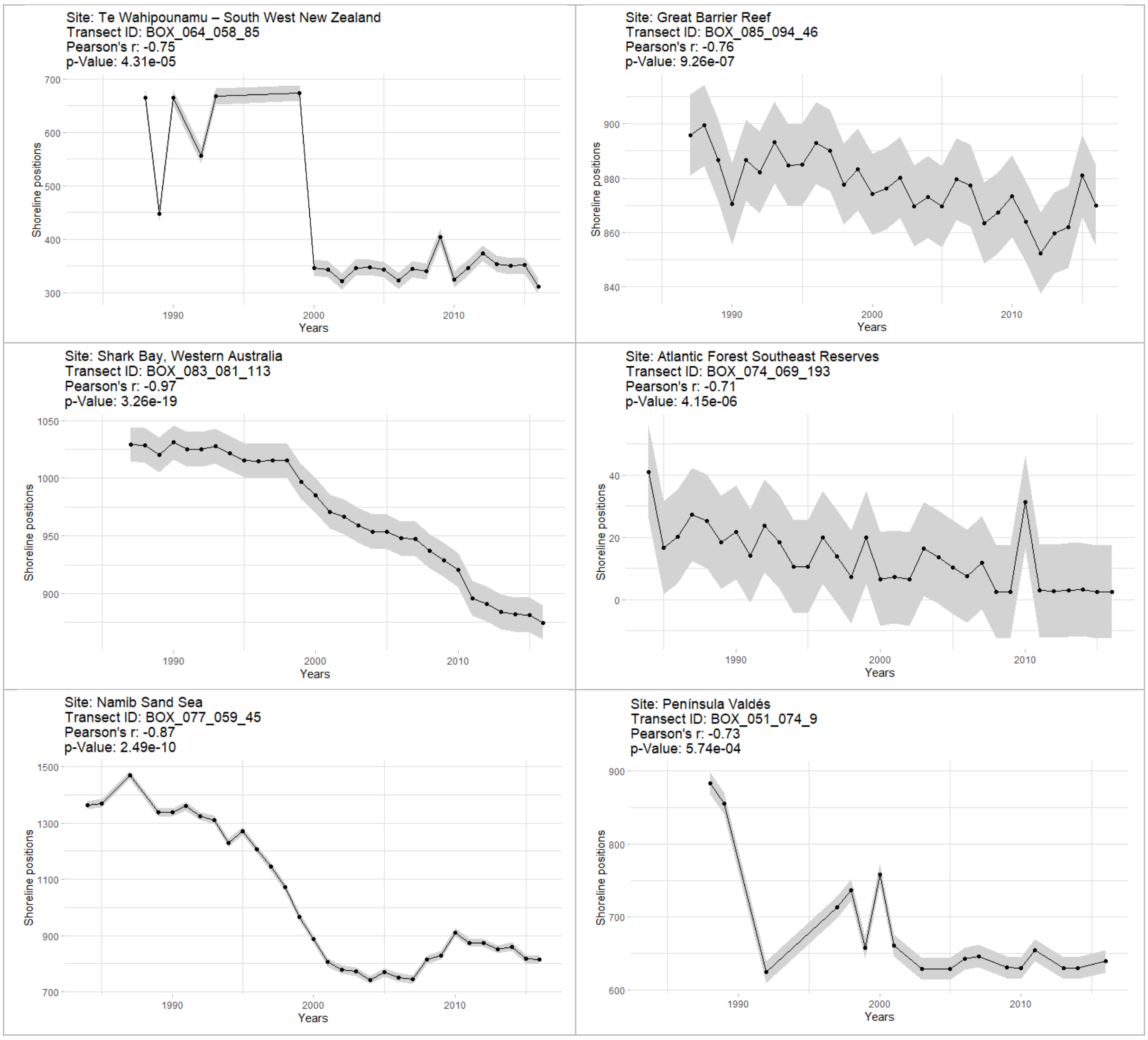


Figure SM4 Examples of transect based strong linear shoreline trends with negative Pearson's r in coastal NWHS from 1984 to 2016. The confidence interval of [-15, 15 m] is represented in grey. SCR value is an indicative of the result of the linear regression.

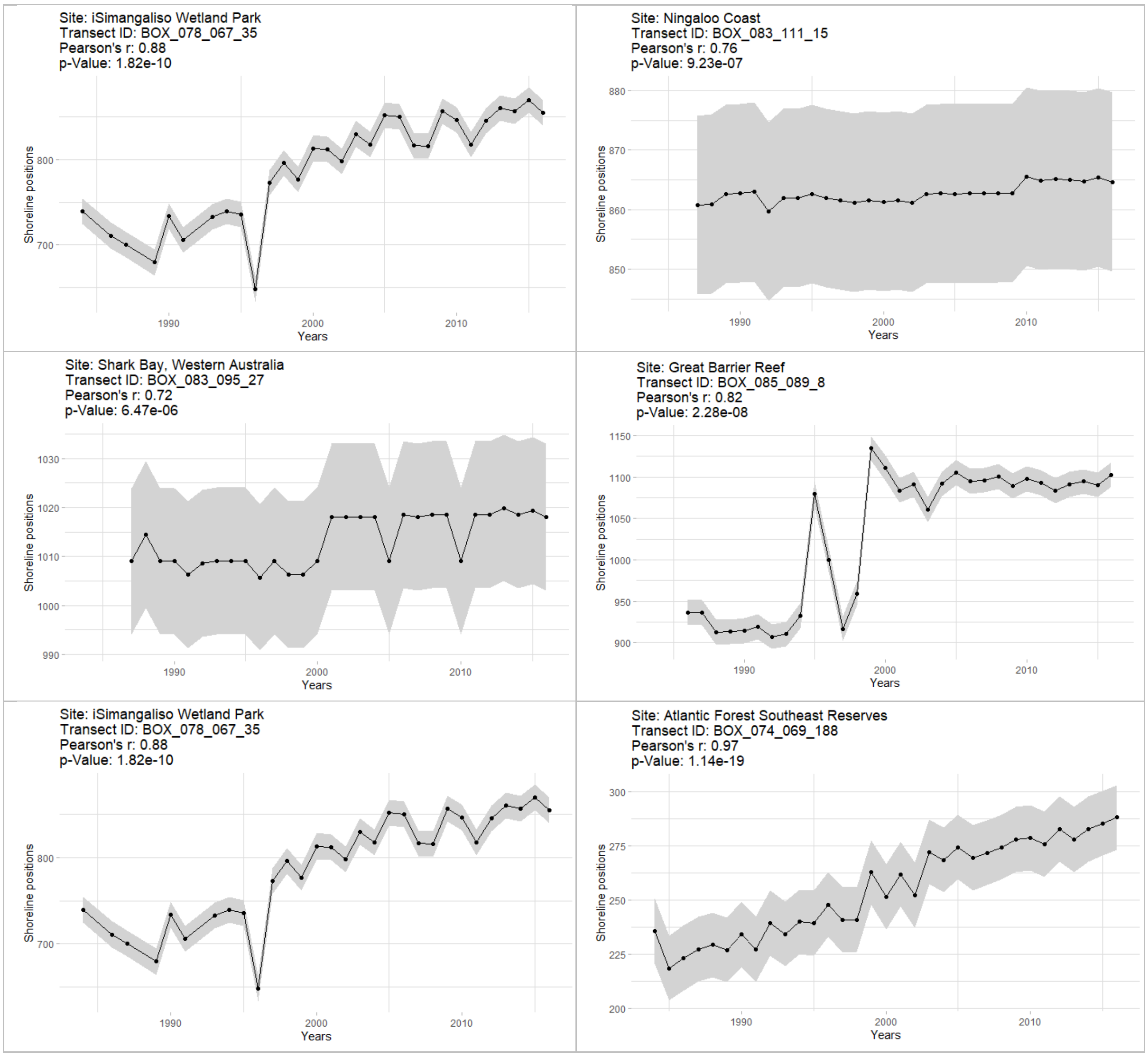


Figure SM5 Examples of transect based strong linear shoreline trends with positive Pearson's r in coastal NWHS from 1984 to 2016. The confidence interval of [-15, 15 m] is represented in grey. SCR value is an indicative of the result of the linear regression.

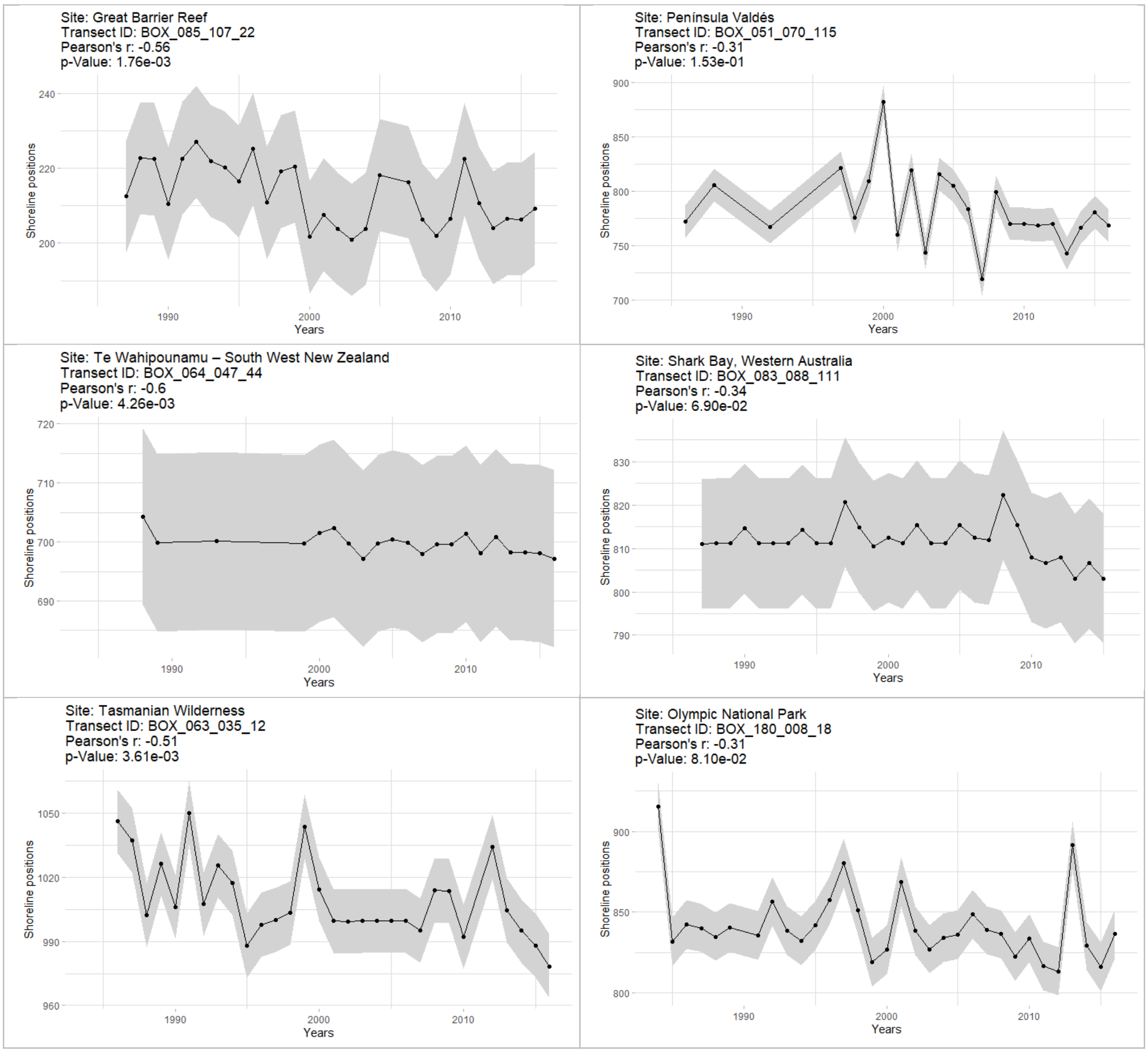


Figure SM6 Examples of transect based weak linear shoreline trends with negative Pearson's r in coastal NWHS from 1984 to 2016. The confidence interval of [-15, 15 m] is represented in grey. SCR value is an indicative of the result of the linear regression.

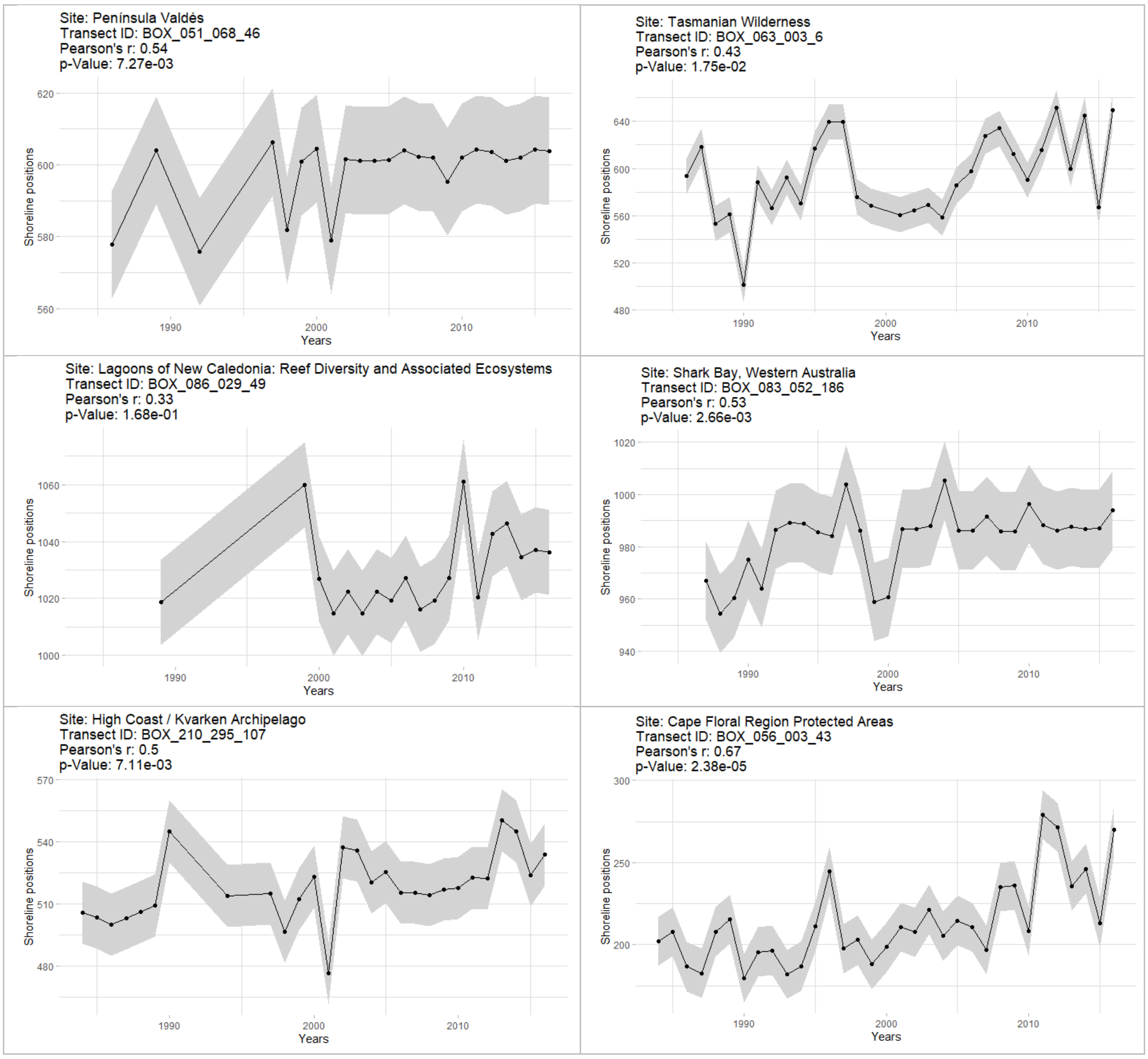


Figure SM7 Examples of transect based weak linear shoreline trends with positive Pearson's r in coastal NWHS from 1984 to 2016. The confidence interval of [-15, 15 m] is represented in grey. SCR value is an indicative of the result of the linear regression.

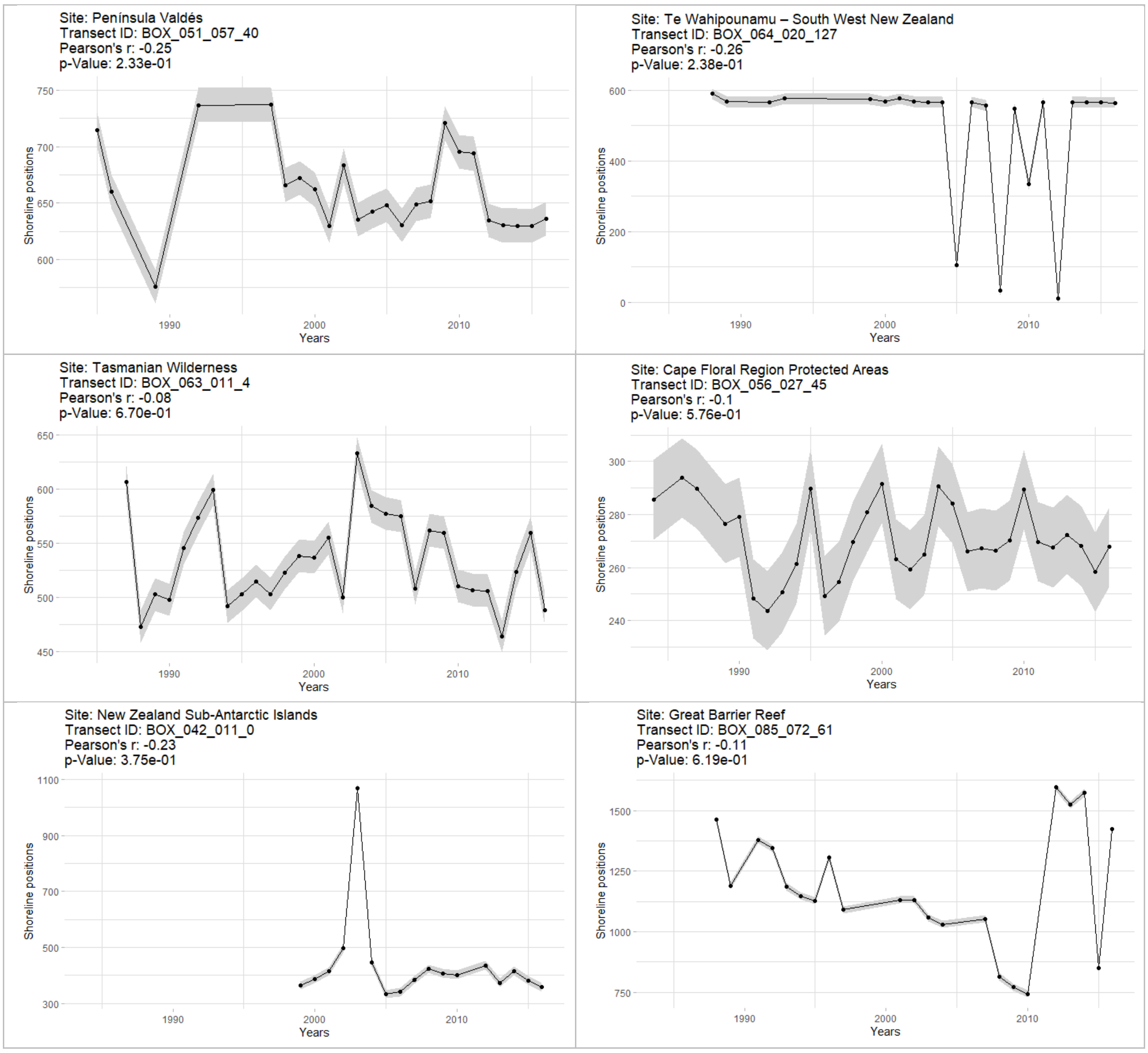


Figure SM8 Examples of transect based non-linear shoreline trends with negative Pearson's r in coastal NWHS from 1984 to 2016. The confidence interval of [-15, 15 m] is represented in grey. SCR value is an indicative of the result of the linear regression.

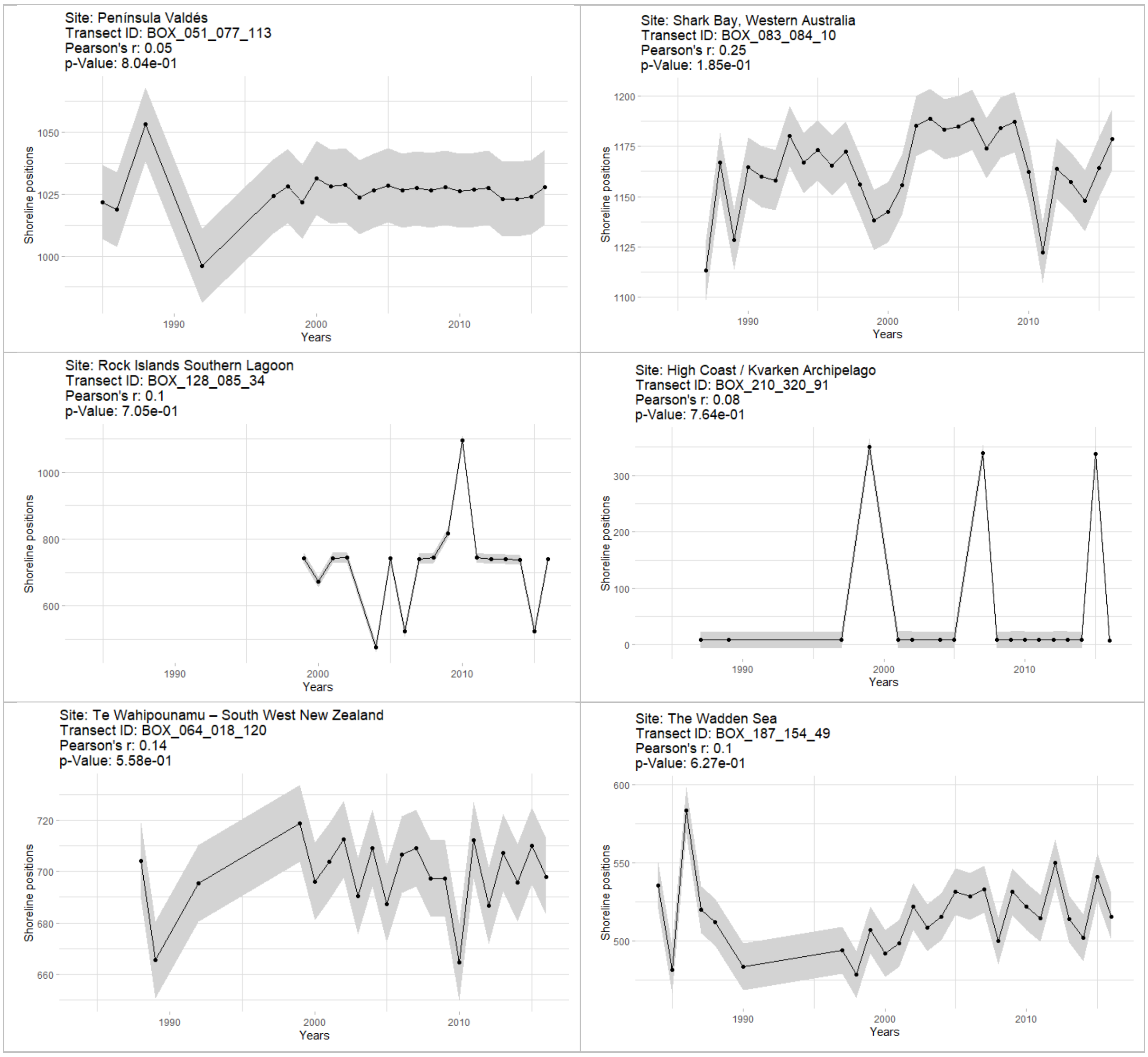


Figure SM9 Examples of transect based non-linear shoreline trends with positive Pearson's r in coastal NWHS from 1984 to 2016. The confidence interval of [-15, 15 m] is represented in grey. SCR value is an indicative of the result of the linear regression.

A.2.2 Strong linear shoreline change behaviour

Outliers that fall outside of the three standard deviation confidence range are removed for each category (< -21.16 m yr^{-1} for recessional transects and > 235 m yr^{-1} for depositional transects) (Figure 10, 11). 1.97% of the depositional transects (60 transects) and 2.14% of the recessional transects (80 transects) are removed.

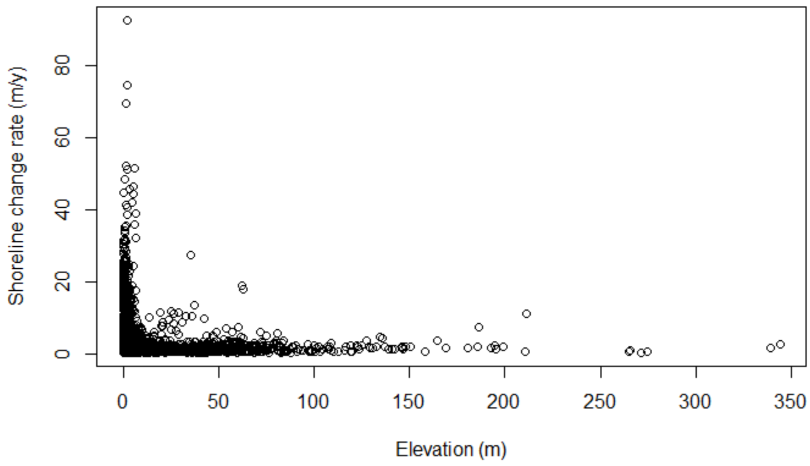


Figure SM10 Distribution of transect-based strong linear depositional SCR (>0.5 m yr^{-1}) in term of their mean elevation.

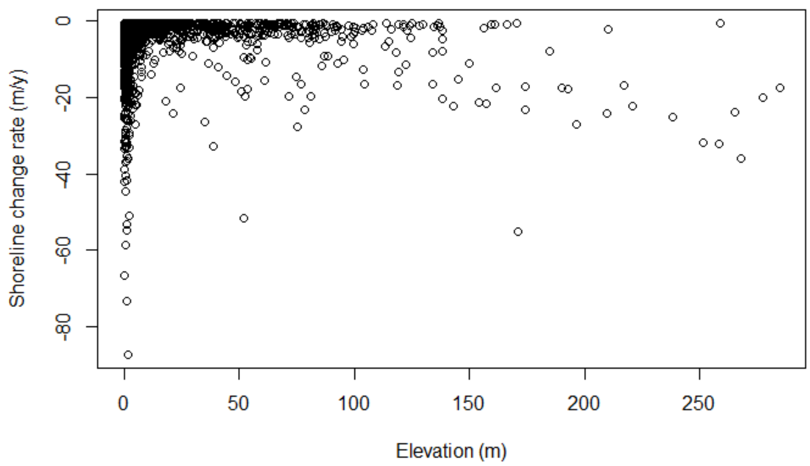


Figure SM11 Distribution of transect-based strong linear recessional SCR (<-0.5 m yr^{-1}) in term of their mean elevation.

Table SM8 For each site, the table presents the percentage of transects for recessional, depositional and stable shoreline trends within the 52 coastal NWHS with a strong linear shoreline behaviour. The sites are classified in descending order of the total number of transects per site.

Name	Total transects	Percentage of transects (%)		
		Recessional trend	Depositional trend	Stable trend
Great Barrier Reef	1518	57	38	5
Shark Bay, Western Australia	730	39.2	48.6	12.2
Islands and Protected Areas of the Gulf of California	625	53.9	40.8	5.3
The Sundarbans	622	84.9	14.5	0.6
Sundarbans National Park	581	71.4	23.2	5.3
The Wadden Sea	471	49	51	0
High Coast / Kvarken Archipelago	291	4.8	91.1	4.1
Ningaloo Coast	263	23.6	68.8	7.6
Galápagos Islands	244	64.3	35.7	0
Banc d'Arguin National Park	231	1.7	98.3	0
Danube Delta	197	66.5	33.5	0
Kakadu National Park	148	45.3	52.7	2
Whale Sanctuary of El Vizcaino	123	75.6	19.5	4.9
Tasmanian Wilderness	118	17.8	81.4	0.8
Everglades National Park	114	74.6	18.4	7
Fraser Island	110	53.6	42.7	3.6
Namib Sand Sea	86	53.5	46.5	0
Te Wahipounamu – South West New Zealand	75	69.3	28	2.7
Atlantic Forest Southeast Reserves	73	56.2	42.5	1.4
Volcanoes of Kamchatka	41	97.6	2.4	0
Lorentz National Park	30	46.7	53.3	0
Shiretoko	28	57.1	42.9	0
Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems	27	63	37	0
Ujung Kulon National Park	26	84.6	15.4	0
Cape Floral Region Protected Areas	24	12.5	87.5	0
Tropical Rainforest Heritage of Sumatra	21	66.7	33.3	0
Península Valdés	13	46.2	23.1	30.8
Komodo National Park	11	45.5	54.5	0
Discovery Coast Atlantic Forest Reserves	11	9.1	81.8	9.1
Redwood National and State Parks	10	10	90	0
iSimangaliso Wetland Park	10	0	100	0
Sanganeb Marine National Park and Dungonab Bay - Mukkawar Island Marine National Park	9	55.6	33.3	11.1
Río Plátano Biosphere Reserve	8	50	50	0
Gros Morne National Park	8	37.5	62.5	0
Socotra Archipelago	8	37.5	62.5	0
Sian Ka'an	7	14.3	85.7	0
West Norwegian Fjords – Geirangerfjord and Nærøyfjord	7	14.3	85.7	0
Area de Conservación Guanacaste	4	25	75	0
Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve	3	100	0	0
Doñana National Park	3	33.3	66.7	0
Rainforests of the Atsinanana	3	33.3	66.7	0
Wet Tropics of Queensland	3	33.3	66.7	0
Desembarco del Granma National Park	2	100	0	0
Jeju Volcanic Island and Lava Tubes	2	50	50	0
Coiba National Park and its Special Zone of Marine Protection	1	100	0	0
Isole Eolie (Aeolian Islands)	1	100	0	0
Joggins Fossil Cliffs	1	100	0	0
Rock Islands Southern Lagoon	1	100	0	0
Alejandro de Humboldt National Park	1	0	100	0

Central Sikhote-Alin	1	0	100	0
Dorset and East Devon Coast	1	0	100	0
Miguasha National Park	1	0	0	100

Table SM9 For each site, the table presents (1) the number of transects, (2) the mean rate of change and (3) the standard deviation for recessional, depositional and stable shoreline trend categories within the 52 coastal NWHS with a strong linear shoreline behaviour. The sites are classified in descending order of the site-based mean rate of strong linear recessional SCR.

	Recessional shoreline change			**Depositional shoreline change**			**Stable shoreline change**		
Name	**Number of transects**	**Mean (m yr^{-1})**	**Std (m yr^{-1})**	**Number of transects**	**Mean (m yr^{-1})**	**Std (m yr^{-1})**	**Number of transects**	**Mean (m yr^{-1})**	**Std (m yr^{-1})**
Río Plátano Biosphere Reserve	4	-11.8	7	4	2.7	2.8	0	0	0
Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve	3	-9.4	3.5	0	0	0	0	0	0
Redwood National and State Parks	1	-9.3	0	9	3.7	2.1	0	0	0
Te Wahipounamu – South West New Zealand	52	-8.6	6.7	21	1.8	0.7	2	-0.3	0.2
Socotra Archipelago	3	-7.8	0.9	5	5.4	1.5	0	0	0
The Wadden Sea	231	-7.5	4.6	240	10.9	5.7	0	0	0
Península Valdés	6	-7.2	5.4	3	0.7	0.2	4	0	0.4
Namib Sand Sea	46	-6.7	5	40	7.6	5.6	0	0	0
Atlantic Forest Southeast Reserves	41	-4.9	5.6	31	2.1	2.1	1	-0.4	0
The Sundarbans	528	-4.8	4	90	4.6	5.5	4	-0.4	0.1
Danube Delta	131	-4.6	2.9	66	4.6	4.9	0	0	0
High Coast / Kvarken Archipelago	14	-4.6	6.7	265	3.5	4.5	12	0.4	0.1
West Norwegian Fjords – Geirangerfjord and Nærøyfjord	1	-4.6	0	6	3	4.1	0	0	0
Ujung Kulon National Park	22	-4.4	5	4	1.3	1.4	0	0	0
Lorentz National Park	14	-4.3	4.7	16	6.6	4.8	0	0	0
Galápagos Islands	157	-4.1	1.9	87	3	1.1	0	0	0
Kakadu National Park	67	-4	4.3	78	2.8	2.8	3	0.4	0.1
Islands and Protected Areas of the Gulf of California	337	-3.4	3.7	255	3.5	4.2	33	0.1	0.4
Whale Sanctuary of El Vizcaino	93	-3.3	3.1	24	3.4	2.8	6	-0.4	0.2
Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems	17	-3	1.3	10	4.1	2.9	0	0	0
Volcanoes of Kamchatka	40	-2.8	2.7	1	1.5	0	0	0	0
Great Barrier Reef	865	-2.3	2.3	577	2.1	2.8	76	-0.1	0.4
Coiba National Park and its Special Zone of Marine Protection	1	-2.3	0	0	0	0	0	0	0
Sundarbans National Park	415	-2.2	1.6	135	2	2.1	31	-0.2	0.4
Everglades National Park	85	-1.9	2.1	21	1.8	2.2	8	0	0.5
Komodo National Park	5	-1.8	1	6	2.8	1.6	0	0	0
Tasmanian Wilderness	21	-1.8	0.5	96	2.3	1.8	1	-0.5	0
Banc d'Arguin National Park	4	-1.8	1.3	227	6.1	3.9	0	0	0
Cape Floral Region Protected Areas	3	-1.7	0.2	21	2	0.5	0	0	0

Isole Eolie (Aeolian Islands)	1	-1.7	0	0	0	0	0	0	0
Wet Tropics of Queensland	1	-1.6	0	2	0.7	0.2	0	0	0
Shiretoko	16	-1.3	0.3	12	2.4	0.8	0	0	0
Sian Ka'an	1	-1.3	0	6	4.5	5.2	0	0	0
Rock Islands Southern Lagoon	1	-1.3	0	0	0	0	0	0	0
Fraser Island	59	-1.2	0.7	47	2.8	3	4	0.2	0.4
Doñana National Park	1	-1.2	0	2	5.7	0.2	0	0	0
Tropical Rainforest Heritage of Sumatra	14	-1.1	0.3	7	1.4	0.8	0	0	0
Shark Bay, Western Australia	286	-1.1	0.9	355	1.4	1.7	89	-0.1	0.4
Ningaloo Coast	62	-1	0.4	181	1	0.6	20	0.1	0.4
Desembarco del Granma National Park	2	-0.9	0.4	0	0	0	0	0	0
Jeju Volcanic Island and Lava Tubes	1	-0.9	0	1	8.4	0	0	0	0
Gros Morne National Park	3	-0.8	0.1	5	1	0.3	0	0	0
Discovery Coast Atlantic Forest Reserves	1	-0.8	0	9	1.1	0.4	1	0.5	0
Area de Conservación Guanacaste	1	-0.8	0	3	1.1	0.2	0	0	0
Sanganeb Marine National Park and Dungonab Bay - Mukkawar Island Marine National Park	5	-0.8	0.4	3	0.6	0.1	1	0.3	0
Rainforests of the Atsinanana	1	-0.7	0	2	1.5	0.1	0	0	0
Joggins Fossil Cliffs	1	-0.6	0	0	0	0	0	0	0
Alejandro de Humboldt National Park	0	0	0	1	1	0	0	0	0
Central Sikhote-Alin	0	0	0	1	0.5	0	0	0	0
Dorset and East Devon Coast	0	0	0	1	1.1	0	0	0	0
iSimangaliso Wetland Park	0	0	0	10	4.9	1.2	0	0	0
Miguasha National Park	0	0	0	0	0	0	1	-0.3	0

A.2.3 Strong linear recessional shoreline trend

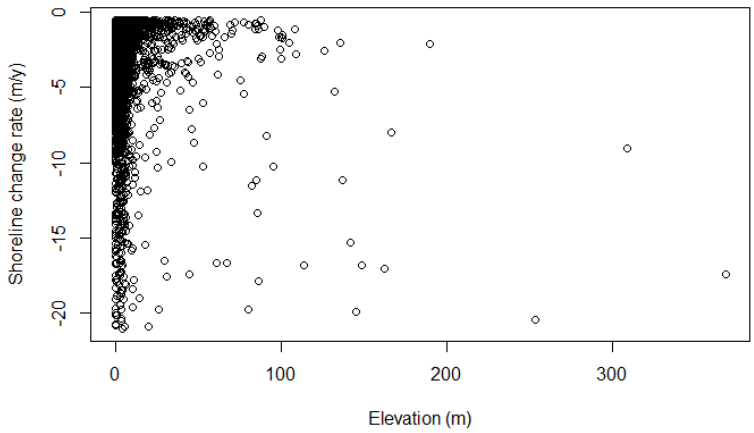


Figure SM12 Distribution of transect-based strong linear recessional SCR in term of their mean elevation (cleaned from outliers).

Table SM10 Mean strong linear recessional SCR (m yr^{-1}) and name of sites within lithological categories for extremely low-lying transects (0 ≤ elevation ≤ 1 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, sc - Carbonate Sedimentary Rocks, sm - Mixed Sedimentary Rocks, mt – Metamorphic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non-vegetated**	**Urban**
Small deltas		su: -1.8 (std 1.6 , Fraser Island, Great Barrier Reef)		su: -3 (std 2, Cape Floral Region Protected Areas, Great Barrier Reef, Islands and Protected Areas of the Gulf of California)		
Tidal systems		su: -2.3 (std 1.7, Sundarbans National Park, The Sundarbans)		sm: -6.8 (std 1.4, The Wadden Sea) ss: -6.9 (std 3.8, The Wadden Sea) su: -8.1 (std 5.2, The Wadden Sea)		
Lagoons		su: -4.8 (std 7.1, Everglades National Park, Islands and Protected Areas of the Gulf of California)	su: -5.1 (std 4.2, Islands and Protected Areas of the Gulf of California)	sc: -3.6 (std 1.6, Danube Delta) ss: -30 (std 0.8, Danube Delta) su: -4.4 (std 2.3, Atlantic Forest Southeast Reserves, Islands and Protected Areas of the Gulf of California)		
Fjords						
Large rivers			ss: -5.6 (std 3.7, Danube Delta)	ss: -5.4 (std 2.4, Danube Delta)		
Large river under tidal influence				su: -6.9 (std 4.1, Islands and Protected Areas of the Gulf of California)	su: -4.7 (std 2.9, Islands and Protected Areas of the Gulf of California)	
Karst						
Arheic		su: -2.7 (std 3.6, Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino)	su: -2.3 (std 2, Islands and Protected Areas of the Gulf of California)	su: -3.4 (std 2.8, Banc d'Arguin National Park, Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino)	su: -2.8 (std 2.9, Islands and Protected Areas of the Gulf of California,	

					Whale Sanctuary of El Vizcaino)	
Islands				mt: -1.2 (std 0.7, High Coast / Kvarken Archipelago)		

Table SM11 Mean strong linear recessional SCR (m yr^{-1}) and name of sites within lithological categories for low-elevated transects (1 < elevation ≤ 10 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, sc - Carbonate Sedimentary Rocks, ev - Evaporites, vb - Basic Volcanic Rocks, vi - Intermediate Volcanic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non-vegetated**	**Urban**
Small deltas	sc: -0.9 (std 0.3 - Desembarco del Granma National Park, Komodo National Park, Ningaloo Coast) su: -1.2 (std 0.6,Great Barrier Reef, Ningaloo Coast)	su: -2.7 (std 2.9 , Fraser Island, Great Barrier Reef, Islands and Protected Areas of the Gulf of California, Wet Tropics of Queensland, Ujung Kulon National Park) vb: -4.8 (std 2.5, Galápagos Islands)	su: -3.7 (std 4.5, Great Barrier Reef)	ev: -7 (std 1.1, Namib Sea) su: -2.5 (std 2.8, Cape Floral Region Protected Areas, Fraser Island, Great Barrier Reef, Islands and Protected Areas of the Gulf of California, Namib Sand Sea, Ningaloo Coast, Shark Bay, Western Australia, Te Wahipounamu – South West New Zealand, Tropical Rainforest Heritage of Sumatra) vb: -4.3 (std 2.2, Galápagos Islands, Volcanoes of Kamchatka) vi: -4.2 (std 3.5, Ujung Kulon National Park, Volcanoes of Kamchatka)		
Tidal systems	su: -3.5 (std 1.1,Great Barrier Reef, Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems)	su: -3.7 (std 3.5, Great Barrier Reef, Kakadu National Park, Sundarbans National Park, The Sundarbans, Lorentz National Park)	su: -2.8 (std 2.3, Kakadu National Park)	ss: -8.9 (std 4.2, The Wadden Sea) su: -4.8 (std 4.1, Discovery Coast Atlantic Forest Reserves, Great Barrier Reef, Kakadu National Park, Sundarbans National Park, Tasmanian Wilderness, The Wadden Sea)		
Lagoons		su: -1.9 (std 2.1, Atlantic Forest Southeast Reserves, Everglades National Park, Islands and Protected Areas of the Gulf of California)		su: -8.3 (std 6.7, Atlantic Forest Southeast Reserves, Islands and Protected Areas of the Gulf of California, Río Plátano Biosphere Reserve)		

Fjords				su: -3.4 (std 2.2, Te Wahipounamu – South West New Zealand)		
Large rivers						
Large river under tidal influence				su: -5.9 (std 4.5, Islands and Protected Areas of the Gulf of California)		
Karst		su: -1.1 (std 0.3, Everglades National Park)				
Arheic		su: -2.2 (std 2.5, Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino)	su: -3.1 (std 1, Islands and Protected Areas of the Gulf of California)	ss: -1.4 (std 1.5, Shark Bay, Western Australia, Whale Sanctuary of El Vizcaino) su: -1.7 (std 1.7, Banc d'Arguin National Park, Islands and Protected Areas of the Gulf of California, Shark Bay, Western Australia, Whale Sanctuary of El Vizcaino)	su: -3.6 (std 2.1, Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino)	
Islands				su: -0.9 (std 0.4, Islands and Protected Areas of the Gulf of California, Sanganeb Marine National Park and Dungonab Bay - Mukkawar Island Marine National Park)		

Table SM12 Mean strong linear recessional SCR (m yr^{-1}) and name of sites within lithological categories for middle-elevated transects (10 < elevation ≤ 50 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, mt - Metamorphic Rocks, pa - Acid Plutonic Rocks, vb - Basic Volcanic Rocks, va - Acid Volcanic Rocks, vi - Intermediate Volcanic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non vegetated**	**Urban**
Small deltas	pa: -1.1 (std 0.3, Great Barrier Reef) su: -1.6 (SD = 0.9 - Great Barrier Reef, Ningaloo Coast) va: -0.7 (std 0.3, Great Barrier Reef) vi: -4.5 (std 6.4, Ujung Kulon National Park)	su: -1.4 (std 0.7 , Fraser Island, Great Barrier Reef, Wet Tropics of Queensland)		pa:-1.7 (std 1.6:, Great Barrier Reef, Volcanoes of Kamchatka) ss: -4.3 (std 4.5, Great Barrier Reef, Península Valdés, Redwood National and State Parks, Te Wahipounamu – South West New Zealand, Volcanoes of Kamchatka) su: -2.3 (std 3.7, Fraser Island, Great Barrier Reef, Namib Sand Sea, Ningaloo Coast, Shark Bay, Western Australia, Te Wahipounamu – South West New Zealand, Tropical Rainforest Heritage of Sumatra) va: -1.4 (std 1.6, Great Barrier Reef, Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve) vb: -3.4 (std 1.3, Galápagos Islands, Shiretoko) vi: -3.7 (std 4.3, Ujung Kulon National Park, Volcanoes of Kamchatka)		
Tidal systems	su: -3.8 (std 0.7, Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems)	su: -3.4 (std 4.2, Lorentz National Park, The Sundarbans)		mt: -1.6 (std 0.2, Tasmanian Wilderness)		
Lagoons		su: -1.2 (std 0.5, Atlantic Forest Southeast Reserves, Everglades National Park)				

Fjords				su: -7.5 (std 7.2, Te Wahipounamu – South West New Zealand)		
Large rivers						
Large river under tidal influence						
Karst						
Arheic				ss: -0.7 (std 0.2, Shark Bay, Western Australia) su: -0.9 (std 0.4, Islands and Protected Areas of the Gulf of California, Shark Bay, Western Australia, Whale Sanctuary of El Vizcaino)		
Islands						

Table SM13 Mean strong linear recessional SCR (m yr^{-1}) and name of sites within lithological categories for high-elevated transects (50 < elevation ≤ 400 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: mt - Metamorphic Rocks, pa - Acid Plutonic Rocks, vb - Basic Volcanic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non vegetated**	**Urban**
Small deltas				pa: -3.1 (std 4.5, Great Barrier Reef, Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve, Volcanoes of Kamchatka) vb: -2.3 (std 1.3, Galápagos Islands, Shiretoko)		
Tidal systems						
Lagoons						
Fjords				mt: -13.1 (std 6.2, Te Wahipounamu – South West New Zealand, West Norwegian Fjords – Geirangerfjord and Nærøyfjord)		
Large rivers						
Large river under tidal influence						
Karst						
Arheic						
Islands						

A.2.4 Strong linear depositional shoreline trend

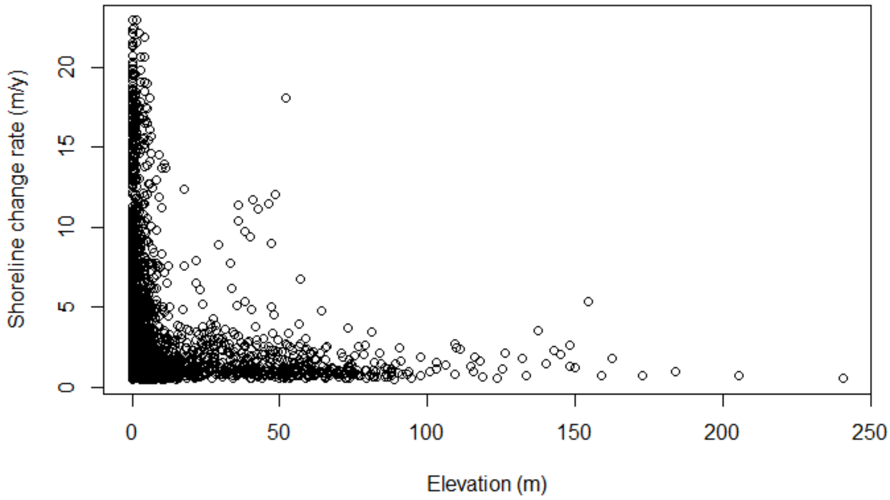


Figure SM13 Distribution of transect-based strong linear depositional SCR in term of their mean elevation (cleaned from outliers).

Table SM14 Mean strong linear depositional SCR (m yr^{-1}) and name of sites within lithological categories for extremely low-lying transects (0 ≤ elevation ≤ 1 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, sc - Carbonate Sedimentary Rocks, mt – Metamorphic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non-vegetated**	**Urban**
Small deltas				su: 5.8 (std 2.9, *Banc d'Arguin National Park, Ningaloo Coast*)		
Tidal systems				ss: 10.9 (std 5.4, *The Wadden Sea*) su: 12.5 (std 5.4, The Wadden Sea)		
Lagoons				sc: 6.9 (std 5.6, *Danube Delta*) ss: 2.5 (std 0.7, *Danube Delta*)		
Fjords						
Large river			ss: 5.4 (std 7.1, *Danube Delta*)	ss: 7.3 (std 6, *Danube Delta*)		
Large river under tidal influence				su: 11 (std 5, *Islands and Protected Areas of the Gulf of California*)		
Karst						
Arheic		su: 2.6 (std 1.7, *Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino*)	su: 7.1 (std 5.4, *Islands and Protected Areas of the Gulf of California*)	ss: 8.5 (std 4, *Banc d'Arguin National Park*) su: 5.7 (std 3.9, *Banc d'Arguin National Park, Islands and Protected Areas of the Gulf of California, Shark Bay, Western Australia, Whale Sanctuary of El Vizcaino*)	su: 3.8 (std 1.6, Banc d'Arguin National Park, *Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino*)	
Islands				mt: 3.6 (std 4.5, *High Coast / Kvarken Archipelago, Islands and Protected Areas of the Gulf of California*)		

Table SM15 Mean strong linear depositional SCR (m yr^{-1}) and name of sites within lithological categories for low-elevated transects (1 < elevation ≤ 10 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, sc - Carbonate Sedimentary Rocks, mt - Metamorphic Rocks, sm - Mixed Sedimentary Rocks, ev - Evaporites, pa - Acid Plutonic Rocks, vb - Basic Volcanic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non-vegetated**	**Urban**
Small deltas	pa: 1.1 (std 0.3, *Great Barrier Reef*) sc: 1 (std 0.4, *Ningaloo Coast*) ss: 0.9 (std 0.2, *Great Barrier Reef*) su: 1.6 (std 1.7, Area de Conservación Guanacaste, Great Barrier Reef, Ningaloo Coast, Tropical Rainforest Heritage of Sumatra)	su: 2.6 (std 3.2, *Fraser Island, Great Barrier Reef, Islands and Protected Areas of the Gulf of California, Shark Bay, Western Australia, Ujung Kulon National Park, Wet Tropics of Queensland*) vb: 3.5 (std 1, *Galápagos Islands*)	su: 3.1 (std 5.6, Fraser Island, *Great Barrier Reef*)	ev: 13.6 (std 5.3, *Namib Sand Sea*) sc: 0.9 (std 0.6, *Ningaloo Coast*) su: 2.8 (std 3.3, *Banc d'Arguin National Park, Doñana National Park, Fraser Island, Great Barrier Reef, Namib Sand Sea, Ningaloo Coast, Shark Bay, Western Australia, Tropical Rainforest Heritage of Sumatra*) vb: 3.5 (std 1.8, Galápagos Islands, Volcanoes of Kamchatka)		
Tidal systems	su: 2 (std 1.2, Discovery Coast Atlantic Forest Reserves, *Great Barrier Reef, Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems*)	su: 3.1 (std 4, *Discovery Coast Atlantic Forest Reserves, Great Barrier Reef, Kakadu National Park, Lorentz National Park, Sundarbans National Park, The Sundarbans*)	su: 3 (std 2.4, *Kakadu National Park, The Wadden Sea*)	su: 3.7 (std 2.7, Discovery Coast Atlantic Forest Reserves, Great Barrier Reef, Kakadu National Park, Tasmanian Wilderness, The Wadden Sea)		
Lagoons		su: 1.5 (std 1.6, *Atlantic Forest Southeast Reserves, Everglades National Park, Islands and Protected Areas of the Gulf of California, Río Plátano Biosphere Reserve, Sian Ka'an*)		sm: 5.3 (std 0.8, *iSimangaliso Wetland Park*) su: 1.8 (std 1.6, *Atlantic Forest Southeast Reserves, Islands and Protected Areas of the Gulf of California, Río Plátano Biosphere Reserve*)		
Fjords				mt: 4.2 (std 5.5, *High Coast / Kvarken Archipelago*)		

				su: 2 (std 0.4, *Te Wahipounamu – South West New Zealand*)		
Large river						
Large river under tidal influence						
Karst		su: 1.1 (std 0.3, *Everglades National Park*)				
Arheic		su: 2.5 (std 2.7*, Banc d'Arguin National Park, Islands and Protected Areas of the Gulf of California, Whale Sanctuary of El Vizcaino*)		su: 3.1 (std 3.5, *Banc d'Arguin National Park, Islands and Protected Areas of the Gulf of California, Shark Bay, Western Australia, Whale Sanctuary of El Vizcaino*)		
Islands				mt: 2.2 (std 3.2, *High Coast / Kvarken Archipelago*)		

Table SM16 Mean strong linear depositional SCR (m yr^{-1}) and name of sites within lithological categories for middle-elevated transects (10 < elevation ≤ 50 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, sc - Carbonate Sedimentary Rocks, sm - Mixed Sedimentary Rocks, mt - Metamorphic Rocks, pa - Acid Plutonic Rocks, vb - Basic Volcanic Rocks, va - Acid Volcanic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non vegetated**	**Urban**
Small deltas	pa: 1.1 (std 0.5, Great Barrier Reef) su: 1.3 (std 0.8, Great Barrier Reef, Ningaloo Coast, Shark Bay, Western Australia) va: 1.4 (std 1.5, Great Barrier Reef) vb: 3 (std 1.2, Galápagos Islands)	ss: 1.1 (std 0.4, Great Barrier Reef) su: 2.7 (std 4, Fraser Island , Great Barrier Reef) vb: 2.9 (std 1.2, Galápagos Islands)		ss: 2.5 (std 1.6, Cape Floral Region Protected Areas, Great Barrier Reef, Península Valdés, Redwood National and State Parks) su: 1.5 (std 1.3, Fraser Island, Great Barrier Reef, Ningaloo Coast, Shark Bay, Western Australia, Ujung Kulon National Park) va: 0.9 (std 0.4, Great Barrier Reef) vb:2.8 (std 0.8, Galápagos Islands, Shiretoko)		
Tidal systems		su: 4.6 (std 5.4, Kakadu National Park, Lorentz National Park, The Sundarbans)	su: 1.4 (std 0.7, Kakadu National Park)	mt: 2.4 (std 1.2, Tasmanian Wilderness) pb: 2 (std 0.5, Tasmanian Wilderness) sm: 2 (std 0.7, Tasmanian Wilderness) su: 1.6 (std 0.6, Kakadu National Park, Tasmanian Wilderness)		
Lagoons						
Fjords				su: 1.9 (std 0.7, Te Wahipounamu – South West New Zealand)		
Large rivers						

Large river under tidal influence						
Karst						
Arheic	su: 1.8 (std 1.5, Shark Bay, Western Australia)			su: 1.7 (std 2.3, Islands and Protected Areas of the Gulf of California, Shark Bay, Western Australia)		
Islands						

Table SM17 Mean strong linear depositional SCR (m yr^{-1}) and name of sites within lithological categories for high-elevated transects (50 < elevation ≤ 400 m). Only significant categories (> 5 transects) are displayed in the table. Abbreviations: su - Unconsolidated Sediments, ss - Siliciclastic Sedimentary Rocks, sm - Mixed Sedimentary Rocks, mt - Metamorphic Rocks, pa - Acid Plutonic Rocks, pb - Basic-Ultrabasic Plutonic Rocks, vb - Basic Volcanic Rocks, va - Acid Volcanic Rocks.

	Coral reefs	**Mangroves**	**Marshes**	**Vegetated**	**Non vegetated**	**Urban**
Small deltas	va: 1 (std 0.5, Great Barrier Reef)			pa: 1.5 (std 0.7, Cape Floral Region Protected Areas, Great Barrier Reef) ss: 1.7 (std 0.6, Cape Floral Region Protected Areas, Great Barrier Reef) vb: 2.1 (std 0.8, Galápagos Islands, Shiretoko)		
Tidal systems				mt: 1.7 (std 0.4, Tasmanian Wilderness) pb: 2.4 (std 0.5,Tasmanian Wilderness) sm: 4.4 (std 6,Tasmanian Wilderness)		
Lagoons						
Fjords				pb: 1.2 (std 0.8, Gros Morne National Park, West Norwegian Fjords – Geirangerfjord and Nærøyfjord)		
Large rivers						
Large river under tidal influence						
Karst						
Arheic				su: 1.1 (std 0.7, Shark Bay, Western Australia)		
Islands						

A.2.5 Climate variability and sea-level rise analysis

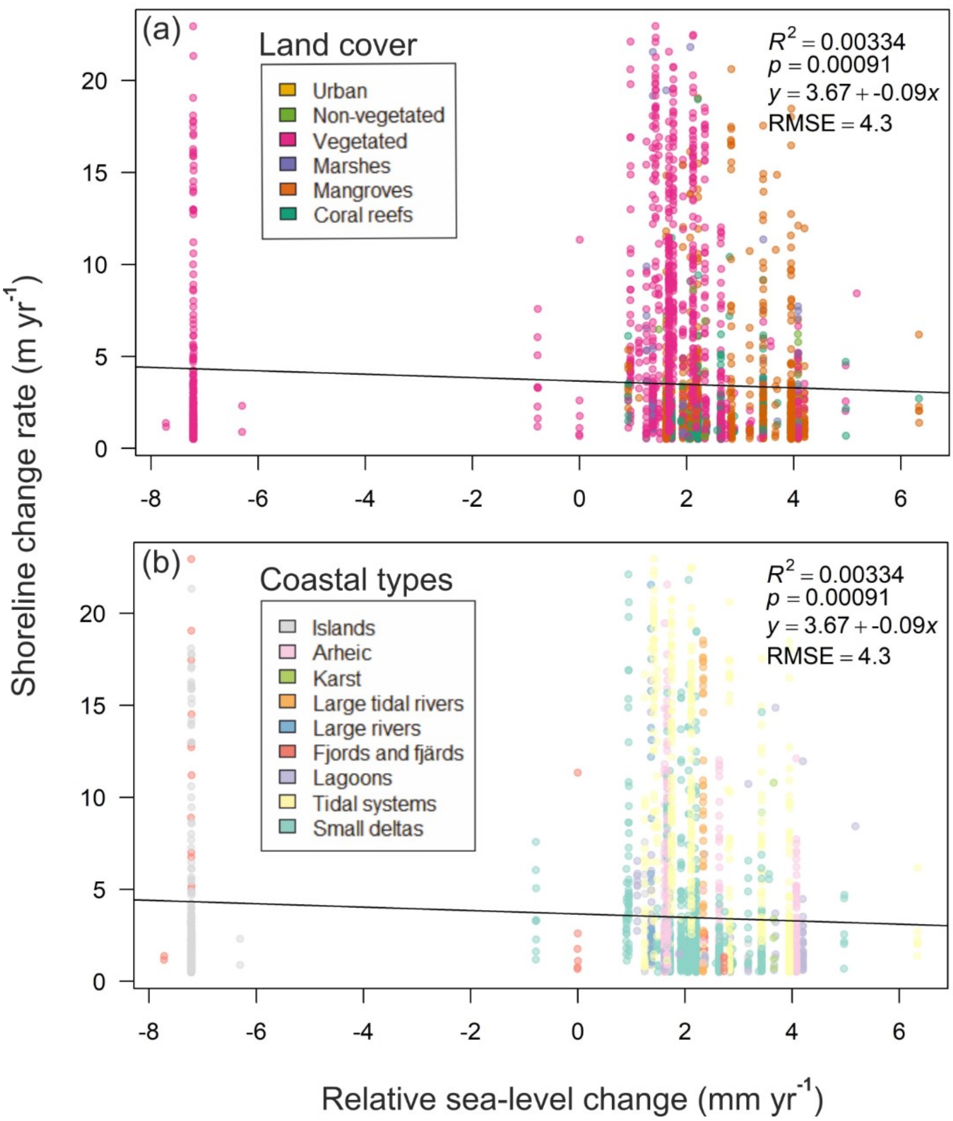
Table SM18 Global percentage of strong linear, non-linear and weak linear transect in term of their Kendall τ correlation with the AMO, AO, NAO, Niño 3, Niño 4, Niño 3.4, ENSO, NP, PDO, and SOI climate indices.

	Percentage of transects - AMO (%)			Percentage of transects - NAO (%)			Percentage of transects - Niño 3 (%)			Percentage of transects - Niño 4 (%)		
	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation
Transect linear classification	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5
Non linear	99.97	0	0.3	99.96	0.02	0.02	99.93	0.02	0.05	99.93	0.01	0.06
Weak Linear	99.6	0.2	0.2	99.99	0.01	0	99.99	0	0.01	99.97	0	0.03
Strong Linear	96.6	1.2	2.2	99.99	0.01	0	100	0	0	100	0	0

	Percentage of transects - AO (%)			Percentage of transects - NP (%)			Percentage of transects - PDO (%)			Percentage of transects - SOI (%)		
	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation
Transect linear classification	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5	-0.5<τ <0.5	τ >= 0.5	τ <= -0.5
Non linear	99.95	0.01	0.1	99.93	0.04	0.03	99.93	0.02	0.05	99.95	0.03	0.02
Weak Linear	99.97	0.01	0.02	99.99	0	0.01	99.96	0	0.04	99.97	0.03	0
Strong Linear	99.99	0	0.01	100	0	0	100	0	0	99.98	0.02	0

	Percentage of transects - Niño 3.4 (%)	Percentage of transects - ENSO (%)

	No correlation	Positive correlation	Negative correlation	No correlation	Positive correlation	Negative correlation
Transect linear classification	$-0.5<\tau <0.5$	$\tau >= 0.5$	$\tau <= -0.5$	$-0.5<\tau <0.5$	$\tau >= 0.5$	$\tau <= -0.5$
Non linear	99.9	0.03	0.07	99.96	0.02	0.02
Weak Linear	99.97	0.01	0.02	99.94	0.02	0.04
Strong Linear	100	0	0	99.97	0	0.03

536 

537 **Figure SM14** Correlation between depositional shoreline change rates and relative sea-level change
538 for low lying transects (0 to 10 m) with a strong linear behaviour. The categorisation of transects is
539 based on their land cover (a) and coastal (b).

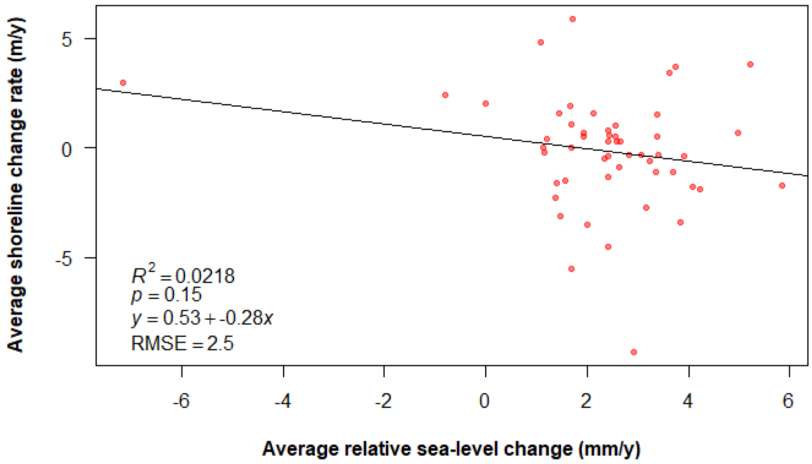


Figure SM15 Correlation between site-based average of strong linear shoreline change rates and relative sea-level change.

A.3 Discussion

In this section, a case study approach is developed to inform the discussion section.

Transects composed of unconsolidated sediments within vegetated lagoons under tidal influences have one of the highest mean rates of change, -8.3 m yr^{-1} (std 6.7 m yr^{-1}) for low-elevation categories (Table SM12). Transects with this erosive shoreline trend are found in *Atlantic Forest Southeast Reserves*, *Islands and Protected Areas of the Gulf of California* and *Río Plátano Biosphere Reserve*. The latter site, situated in Honduras, has the highest mean recessional shoreline change (-11.8 m yr^{-1}, std 7.01) (Table SM10). This erosive trend is mainly due to the opening of an inlet 12km northwest of Iban lagoon in 2002 (see tour opening of an inlet in Río Plátano Biosphere Reserve created using Timelapse – Google Earth Engine[19]) inducing new depositional (northeast of the inlet) and erosive (southwest of the inlet) processes within the coastal boundary of the site (Figure SM16). The latter is influenced by Paulaya river sediment discharge and the southeast-northwest ocean current from Honduras to Yucatan shorelines [20].

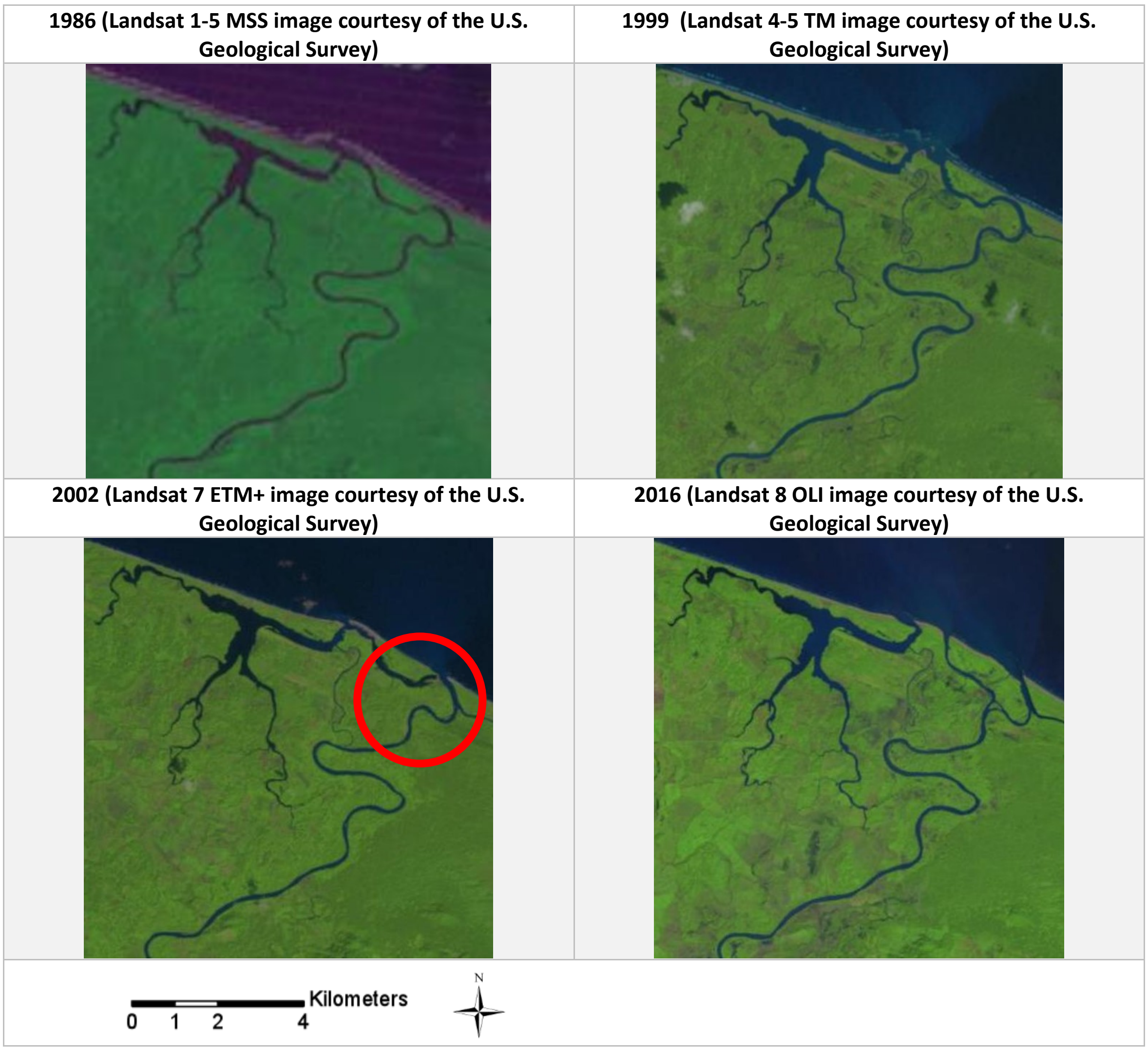


Figure SM16 Photo series of the opening of an inlet in Río Plátano Biosphere Reserve (images recovered from the U.S. Geological Survey LandsatLook Viewer (see https://landsatlook.usgs.gov/viewer.html).

The *Atlantic Forest Southeast Reserves*, in Brazil, is composed of unconsolidated sediments and has a mean erosive rate of -5.3 m yr^{-1} (std 5.9 m yr^{-1}) for extremely low- and low-elevations. The transects are in the flooded rift of Paranaguá bays (Parana coast) within three beach environments:

1. Estuarine tide modified beaches dominated by waves, waves generated currents and ebb- and flood-tidal currents within Ilha do Mel, Ilha das Pecas (islands), and Ilha do Superagui;
2. Transitional beaches influenced by inlet and ebb tides shoal dynamic and Mar do Ararapira and Ilha do Cardoso;
3. Ocean beaches wave-dominated at Ilha do Superagui[21].

The identified stretch of erosive beaches in the *Atlantic Forest Southeast Reserves* have been classified as instable (change of hundreds of meters) or moderately unstable (change of dozens of meters) between 1952 and 1980[22]. Wave-driven longshore current both north and south are interrupted by estuarine inlets tidal currents which induce a sand movement onshore and offshore. Inlets beaches associated with the Canal do Superagui and Ararapira inlets have changed by more than 1 km during the last five decades[21,23]. The largest variations of shorelines in the Paraná coast is associated with the ebb-tide delta situated at the mouth of the Superagui Channel (Figure SM17). At Superagui ebb-tidal delta, gradually increasing erosive transects (from -4 m yr^{-1} to -11 m yr^{-1} from northeast to southwest) by the north-northwest longshore current. The sediment transport of the open beach stretch of the barrier island is interrupted by ebb current and south-southeast opposing wave system, inducing an accretion at the end of the beach arc (Figure SM17).

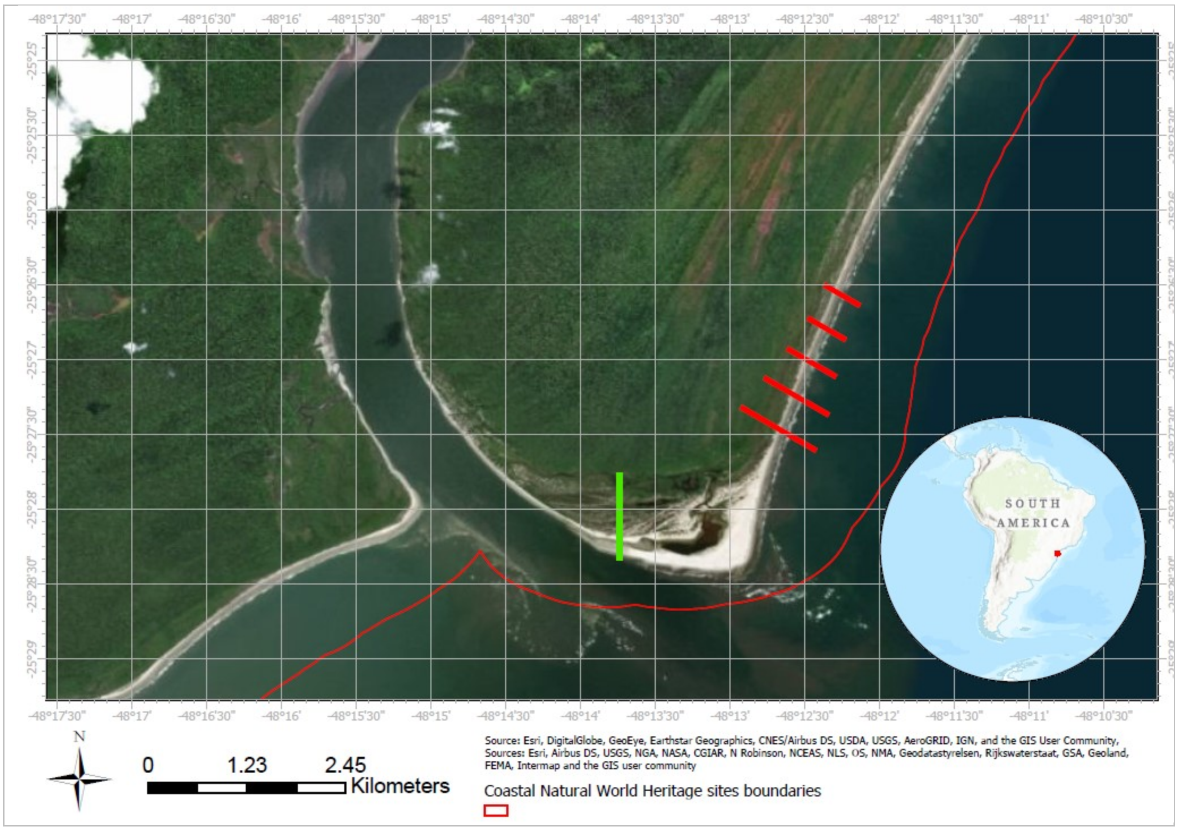


Figure SM17. Erosive and accretive trend from 1984 to 2016 at the barrier island beach arc where red lines reflect an erosive trend and the green line an accretive trend. The increase of the erosive lines' length from northeast to southwest describe the decrease of erosive shoreline rate. These trends have been observed by Angulo *et al.*, 2016, while comparing subaerial beach change in 1980, 1955 and 1952 showing the change of Superagui inlet[21]. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

Centennial to millennial-scale changes at Ararapira Sea (Mar do Ararapira) (Figure SM18) have been identified previously for transects with strong linear accretive and erosive shoreline change. As the Ararapira Sea is parallel to the coastline, the location of the main ebb channel is located near the concave margin. The southwest oriented migration of the mouth of the delta with predominant northeast drift induced periods of upstream sand accumulation, which induces an increase of the hydraulic watering effect when the tidal currents are the strongest. These same currents tend to erode the concave bank of the Ararapira Sea and promote deposition at the convex margin[22]. Souza and Muller, 2009, predicted the erosion of the south mouth of the inlet which is verified by this manuscript's findings[24].

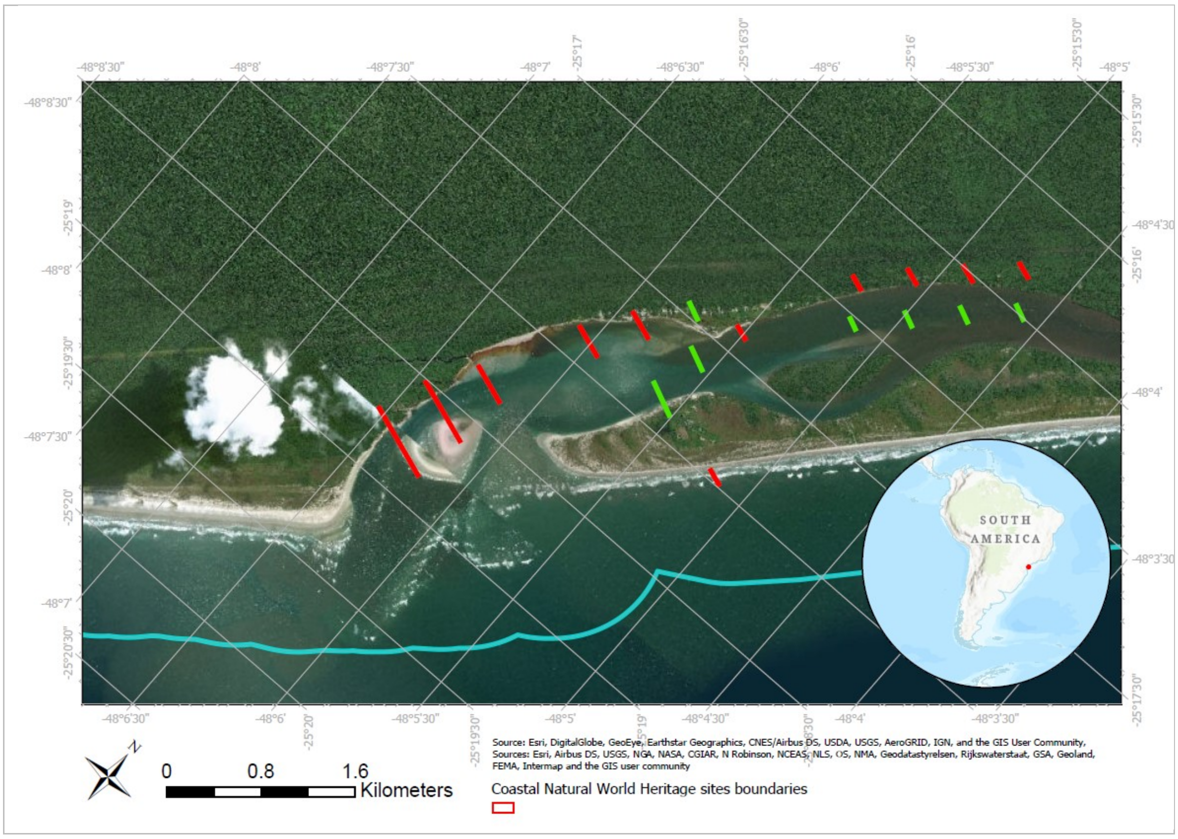


Figure SM18. Linear erosive and accretive trend from 1984 to 2016 at the Ararapira Sea where red lines reflect an erosive trend and the green line an accretive trend. These trends in the Ararapira Sea have been described by Angulo *et al.*, 2004[22]. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

The open coast beaches of the *Atlantic Forest Southeast Reserves*, dominated by low gradient beach profiles, have a decadal stability (less than 10 m over a period of 4/5 decades[21,22]) that is not captured by the selection method of transects with strong linear behaviour. As mentioned, strong linear behaviours detect intense to extreme recessional or accretive shoreline trends (>1 m yr^{-1} or <-1 m yr^{-1}) and do not expose stable or moderate shoreline change trends (between -1 m yr^{-1} and 1 m yr^{-1}). It is also acknowledged that extreme events related changes or cyclic changes are not captured by the selection methodology of linear shoreline behaviours (and thus are part of the weak linear or non-linear shoreline behaviours).

With -8.1 m yr^{-1} (std 5.2), vegetated tidal systems with unconsolidated sediments have the largest erosive shoreline change within extremely low-elevation transects (Table SM11). This category is found in *The Wadden Sea,* that is composed of a chain of barrier islands experiencing both erosion and accretion: uninhabited parts of the islands are subject to natural processes and inhabited parts are artificially protected by dykes[25]. The chain of barrier-islands is broken by inlets and separated from the continental shelf by a tidal flat system. The inlets are under a littoral drift (West to East) generated by wave actions and semi-diurnal tides[26,27]. The mainland of *The Wadden sea* is engineered (sand nourishment, breakwaters dykes, and dunes protection) and prevalence of accretive transects is observed (Figure SM19) [28–30].

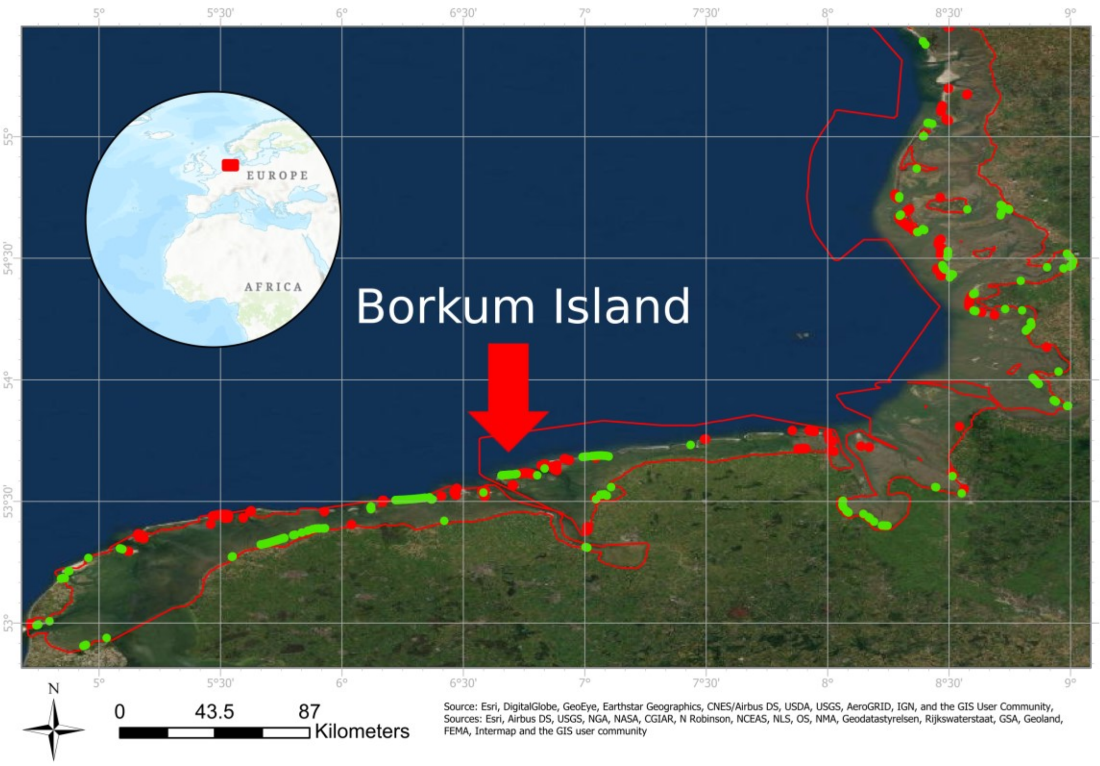


Figure SM19 Strong linear erosive (red) and accretive (green) shoreline trends from 1984 to 2016 in *The Wadden Sea*. A predominance of an accretive trend is observed in the mainland. The position of Borkum island is indicated by the red arrow. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

Borkum island in the western part of Germany is part of this system (Figure SM19), its western spit has been protected by groynes since the last century[31], while the north-eastern beaches experience erosion (east) and accretion (north). The structural development of the foreshore and tidal channel of the Osterems tidal inlet following the silting up and land reclamation of the Ley Bay until 1950 had led to the erosion of the eastern beaches and dunes of the island[27,32]. A stretch of 7 km had been identified as linearly eroding by a mean rate of -6.58 m yr^{-1} (std 1.92 m yr^{-1}) from 1984 to 2016 (Figure SM20). The tidal ebb stream eroding the eastern spit faces the flood stream, which may explain the accretion observed in the northern part of the island (mean 7.42 m yr^{-1}, std 1.53 m yr^{-1}) and the engineered north-western part of the city of Borkum (mean 17.56 m yr^{-1}, std 2.77 m yr^{-1}). In this example, the analysis demonstrates that within coastal NWHS, highly dynamic vegetated beach within tidally influenced barrier islands are experiencing extreme erosive and accretive processes. These ecosystems are experiencing dramatic changes by both natural processes and human interference and need a careful monitoring in the context of coastal protection and nature conservation.

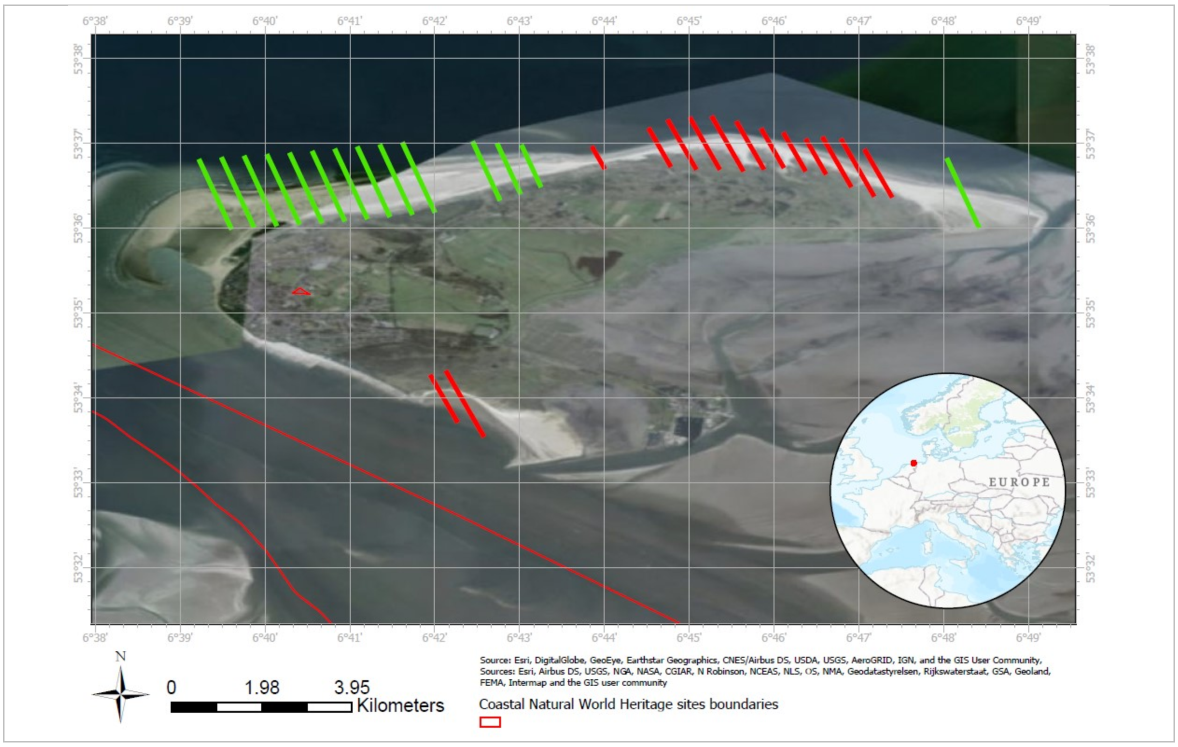


Figure SM20. Linear erosive and accretive trend from 1984 to 2016 at Borkum island where red lines reflect an erosive trend and the green line an accretive trend. The city of Borkum protected by groynes is situated in the west part of the island. The development of the flood- and ebb-channel impacting the northern part of Borkum island between 1874 and 1994 and the predicted 1945 scenario have been described by Kunz, H., 1996[27]. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

In addition to tidal vegetated areas and lagoons, transects within the category of tidally influenced large rivers experience one of the highest erosive shoreline trend within the extremely low- and low elevations categories (-7.9 m yr^{-1}, std 7.7 m yr^{-1} and -5.9 m yr^{-1}, std 4.5 m yr^{-1} respectively). This category is representative of unconsolidated sediments situated at the mouth of the Colorado River in the *Islands and Protected Areas of the Gulf of California* (Sea of Cortez). Two geologic processes control the evolution of the tide-dominated Colorado River Delta: (1) the sediment supply from the Colorado river (160 x 10^6 t/y in 1964[33]) and (2) the tidal regime (12 m) with strong tidal current[34]. Environmental disturbance related to human activities (mining, tourism, damn and water management) has yielded to the interruption of new sediment supply and the absence of constructive processes within the delta from 1998 to 2014[33,35,36]. During this period of clear erosional stage, the hydrographic circulation of the basin has been modified building up sediment toward to western margin of the delta and flushing out suspended sediments. In 2014, the Morelo Damn built on 1950 on the Arizona-Mexico border has been open to allow a “pulse flow” which permit the first contact in 16 years of the river freshwater with the saline water of the Sea of Cortez and has demonstrated positive ecological restoration[36,37]. Erosive transects situated within the mouth of the Colorado River show a stable/cyclic behaviour up to 1990 where an erosive process starts and continues up to 2016 (Figure SM21).

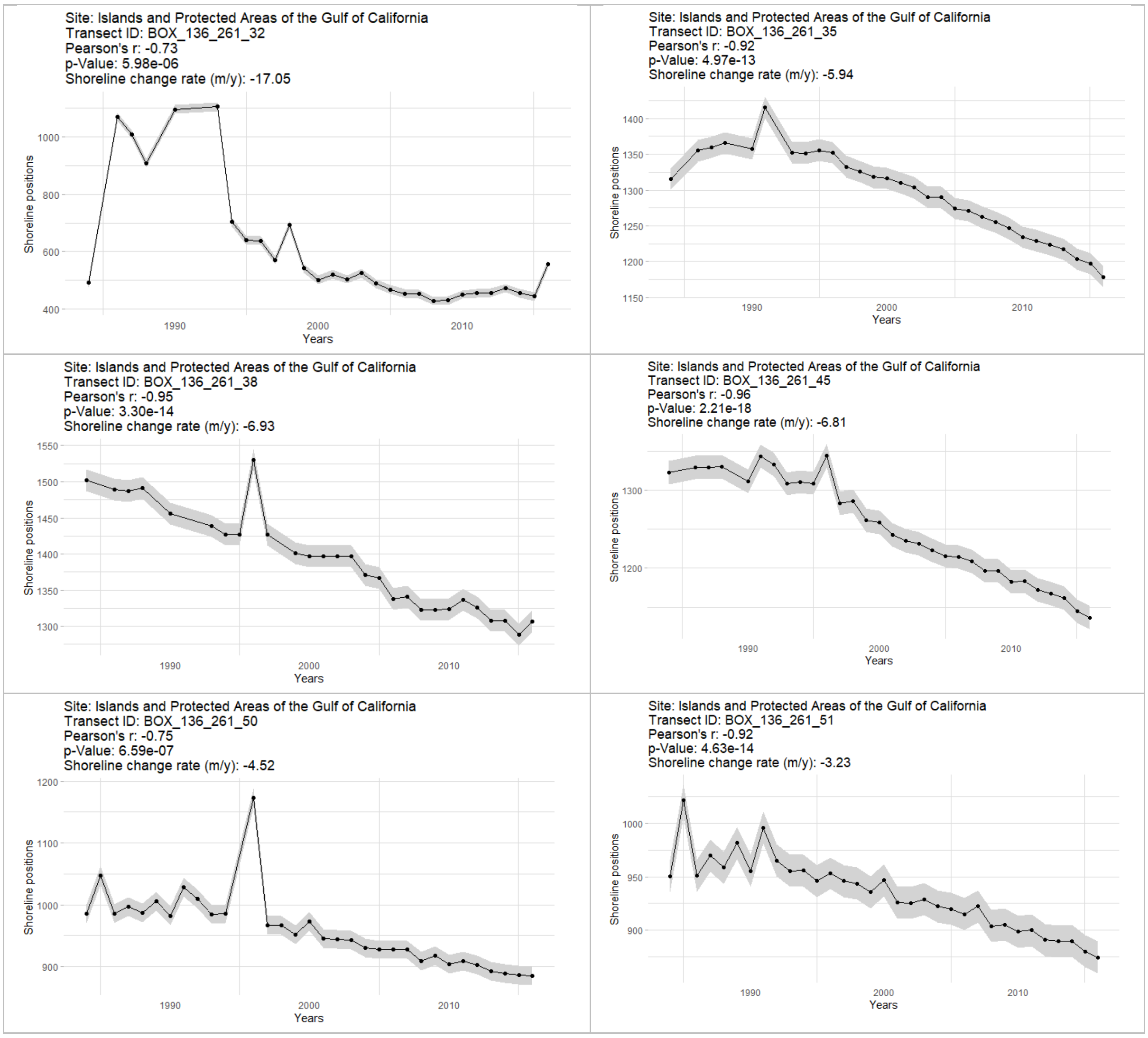


Figure SM21 Time-series of SDS within transects situated within the mouth of the Colorado River.

The effects of the human activities on the mouth Colorado River basin combined to the sediment hydrodynamic unravel accretive and erosive shoreline trends within the rest of the basin. Erosive shoreline trends, along the Sonoran coastline, are due to the combination between the wave-currents bringing sediments from the ocean into the estuarine basin and the northeast-southwest cross-basinal tidal currents carrying winnowed finer-grained sediments from the Sonoran coastline to the Baja Californian coast (Figure SM22). As a result, unconsolidated sediments of the Sonora coast, suspended and winnowed by wave action, are deposited on the Baja Californian coastline[38]. Linear accretive trend is observed southwest of Montague Island (at the mouth of the Colorado River) and can be explained by the interruption of the proportion of sediments transported (around the island) by the cross-basinal tidal currents (Figure SM22). In addition to the erosion and deposition processes, the anthropogenic led change from the brackish to the saline environment of the delta have caused serious ecological impacts to the indigenous fauna and flora (such as the endangered Totoaba (Totoaba macdonaldi) and Vaquita (Phocoena sinus))[38]. While deltas are naturally dynamic systems, the human interventions in their hydrologic basins may be the main force affecting their steady-state of evolution, especially in the context of climate change-induced sea-level rise (sediment deficit) and change in tidal systems.

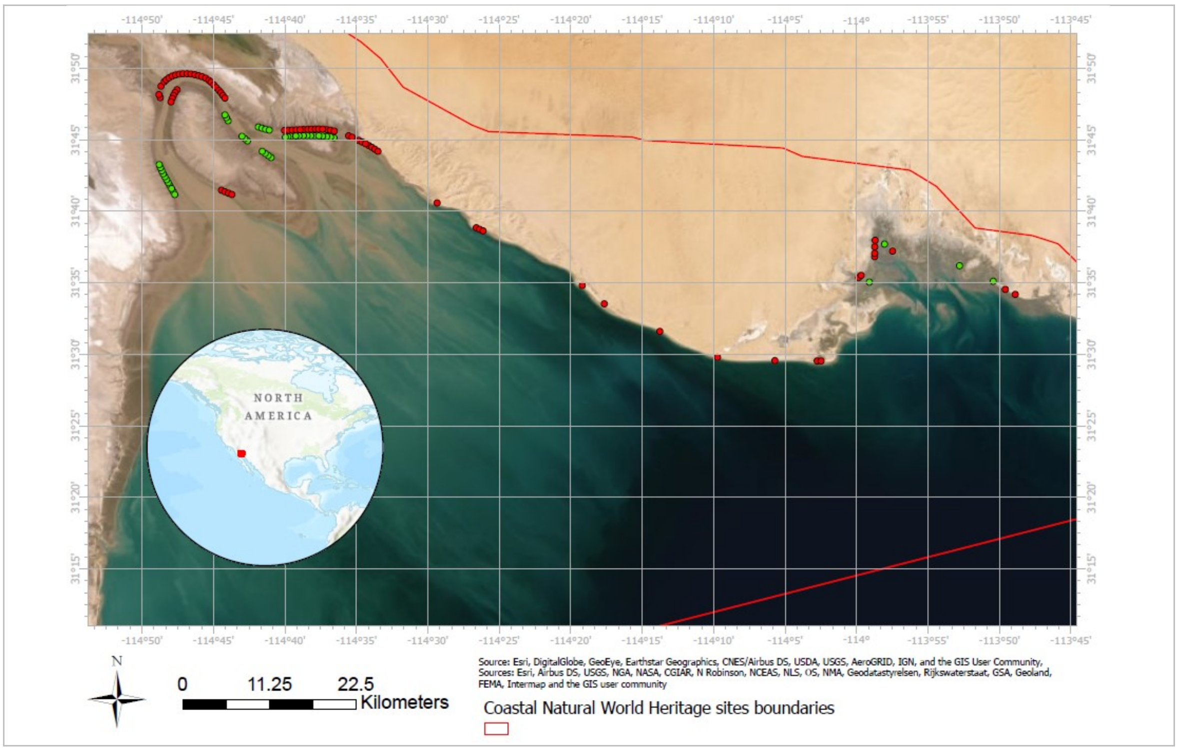


Figure SM22 Linear erosive and accretive trend from 1984 to 2016 at Colorado River in the *Islands and Protected Areas of the Gulf of California* where red lines reflect an erosive trend and the green line an accretive trend. Model of sediment hydrodynamics in the Colorado River has been described by Carriquiry *et al.*, 1999[38]. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

Sediment deposition southwest of the *Namib Sand Sea*'s Conception Bay (evaporite basin) and Sandwich harbour[39] had induced the highest mean accretive shoreline change of all coastal NWHS sites transects classification categories (13.6 m yr^{-1}, std 5.3 m yr^{-1}). Namib Sand Sea is part of the Southwest coast of Africa, which is composed of long sandy beaches, large scale spits, shoreline undulations and shoreline sand waves[40]. The Namib Sand Sea unique ecosystem is shaped by the Benguela Upwelling system driven by the south-easterly trade winds. Evaporite stretches of coast 20 and 50 km south of the Conception Bay (Figure SM23) experience a linear erosion (mean -7.14, std 1.13 m yr^{-1}) likely due to the current of Benguela and the predominant waves coming from a south-southwest directional band[40,41]. The northern curve of the bay, composed of unconsolidated sediments experiences an extreme erosion (-13.32 m yr^{-1}, std 7.93 m yr^{-1}). A similar erosive trend is observed in Sandwich Bay where the large coastal feature (spit) had developed with a mean rate of 6.05 m yr^{-1} (std 4.39 m yr^{-1}) under the wave changing the local orientation of the coastline[41]. The largely enclosed Sandwich Bay, which previously served as commercial fishing and trading harbour, is a brackish lagoon-type wetland of international importance for its birdlife[42]. Its marshes and mudflats have developed due the formation of the coastal spit [41,43,44].

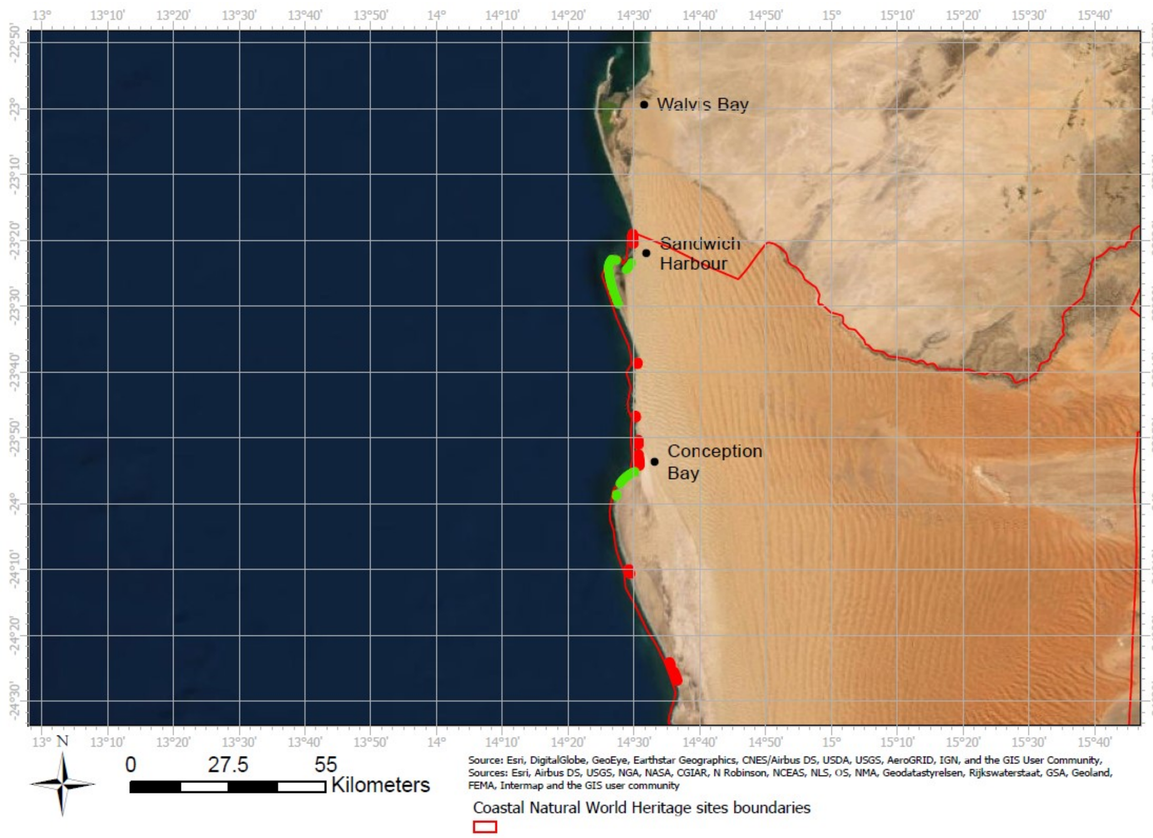


Figure SM23 Linear erosive and accretive shoreline trends along the Namib Sea coastline. The maps are licensed under the Esri Master License Agreement. The licence terms can be found on the following link: https://www.esri.com/en-us/legal/terms/full-master-agreement.

While the shoreline change dataset describes well the changes within continental coastal NWHS with unconsolidated sediments or sedimentary rocks, it does not demonstrate well the shoreline change for sites with coastal transects situated within complex narrow bodies of water as fjords or remote rocky islands. The highest linear erosive shoreline trend within all lithological categories (and all elevations) is within transects composed of metamorphic rocks in Te Wahipounamu – South West New Zealand, and West Norwegian Fjords – Geirangerfjord and Nærøyfjord (-8.57m yr^{-1}, std 6.71 m yr^{-1}). However, a visual verification using Google Time-lapse does not show this extreme linear shoreline trend captured by the SDS. The pristine coastal landscape of Te Whipounamu is composed of fjords, marine terraces, and rocky coasts with an uplifting of 0.3-0.5 mm yr^{-1} [45]. On the south coast of Fiordland, terraces formed by erosion have been uplifted over a million years above 1000 m above sea level[46]. Given its geological and geomorphological characteristics and the visual verification using Google Earth Engine Timelapse, there is little possibility of having an extreme erosive SCR of -18 m yr^{-1}. Moreover, Te wahipounamu transects account for 19% of negative outliers. This finding informs on the limitation of SDS for coastal NWHS, where errors can occur within fjords narrow bodies of water.

In the Galapagos Islands, for which we found an adverse mirroring change between the south and north of the islands: south-western transects experience linear erosive shoreline change while north-eastern transects display linear accretive shoreline change. However, these volcanic islands do not experience gradual shoreline change but abrupt coastal changes during volcanic eruptions. Most of the volcanic islands fate, of which the Galapagos Islands, is to be drowned through subsidence and/or marine erosion, however, the process takes millennia and is not perceptible in a multi-decadal scale. In the decadal scale, coastal transformation is distinguished by expansion through rapid formation of lava deltas followed by fluvial and marine erosive destructive processes that reshape the coastline[47]. A visual verification using Google Time-lapse shows that the trend of change captured by satellite images may be due to a shift in the position of islands from north to south and may be caused by a decrease in the accuracy of satellite images when mapping remote small oceanic islands.

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