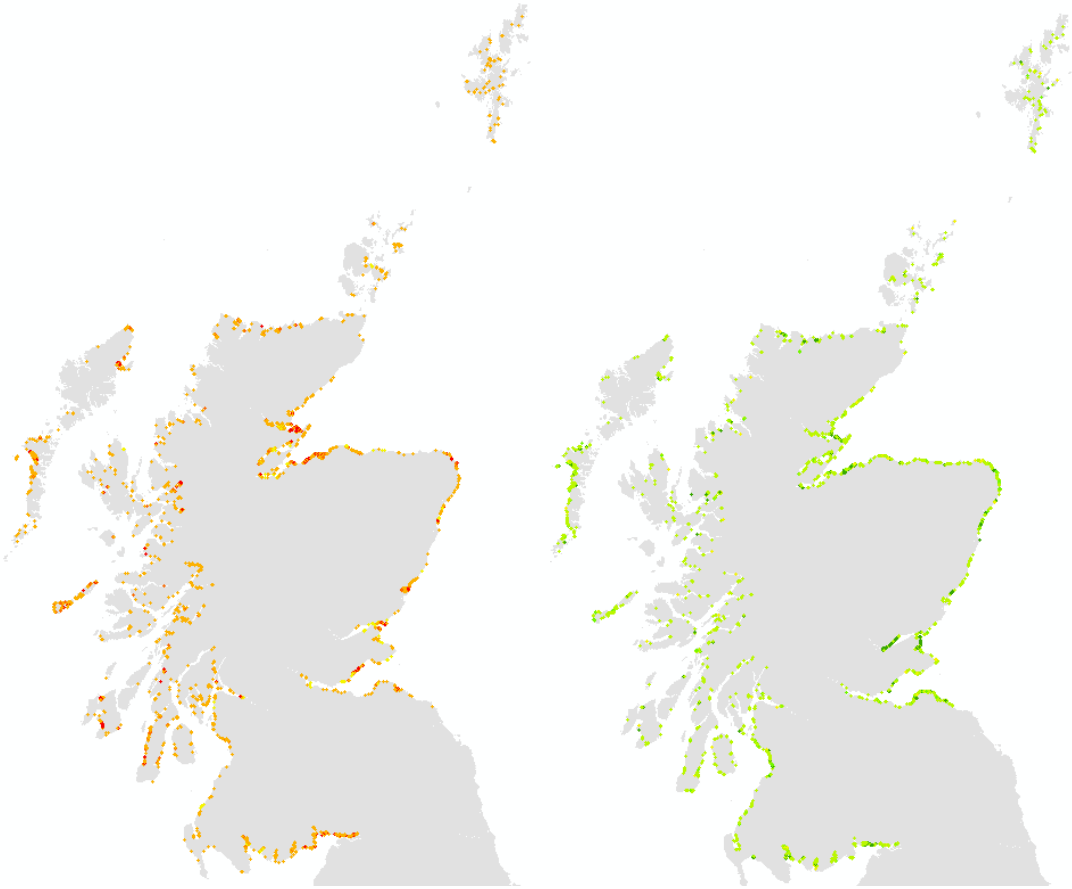
The Scottish Government
Riaghaltas na h-Alba

University of Glasgow

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

Significant erosion
More than 10m of erosion
or faster than 0.5m/yr

Significant accretion
More than 10m of accretion
or faster than +0.5m/yr



National Coastal Change Assessment

MASTS ASM 20th October 2016

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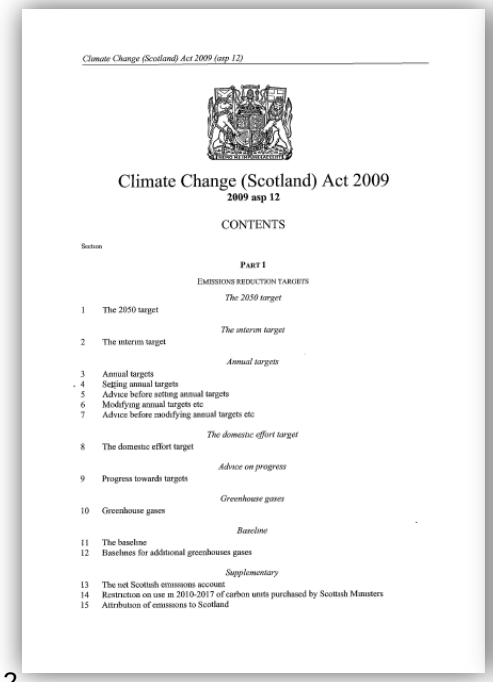
([1] SG / SNH , [2] University of Glasgow)

www.dynamiccoast.com

Climate Change Act (2009)

- Places a duty on Government to address the risks in UK CCRA via the Climate Change Adaptation Programme


(Scottish Cabinet)


Climate Change (Scotland) Act 2009 (asp 12)

Climate Change (Scotland) Act 2009
2009 asp 12

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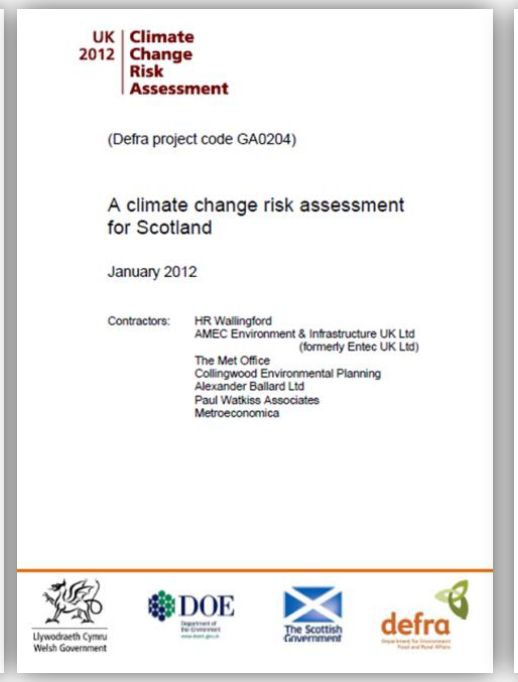

UK 2012 Climate Change Risk Assessment

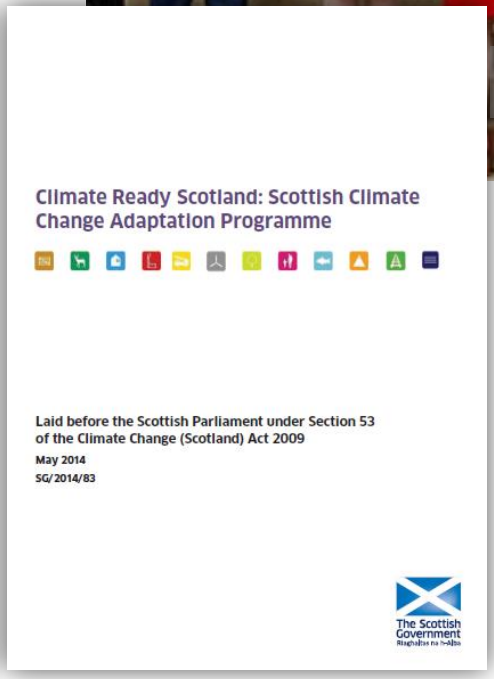
(Defra project code GA0204)

A climate change risk assessment for Scotland

January 2012

Contractors: HR Wallingford
AMEC Environment & Infrastructure UK Ltd (formerly Entec UK Ltd)
The Met Office
Collingwood Environmental Planning
Alexander Ballard Ltd
Paul Watkiss Associates
Metroeconomica

Llywodraeth Cymru Welsh Government · DOE · The Scottish Government · defra


Climate Ready Scotland: Scottish Climate Change Adaptation Programme

Laid before the Scottish Parliament under Section 53 of the Climate Change (Scotland) Act 2009
May 2014
SG/2014/83

The Scottish Government

We expect …

- rising sea level, more coastal erosion and associated increases in coastal flooding to increasingly affect Scotland's soft coastlines, its assets and its communities.
- maps of past erosion, current state and future erosion conditions are required, along with ecosystem service impacts to be assessed.
- put in place Adaptive Measures for our natural heritage
- consider implications of coastal erosion for all of Scotland's assets

(SCCAP)

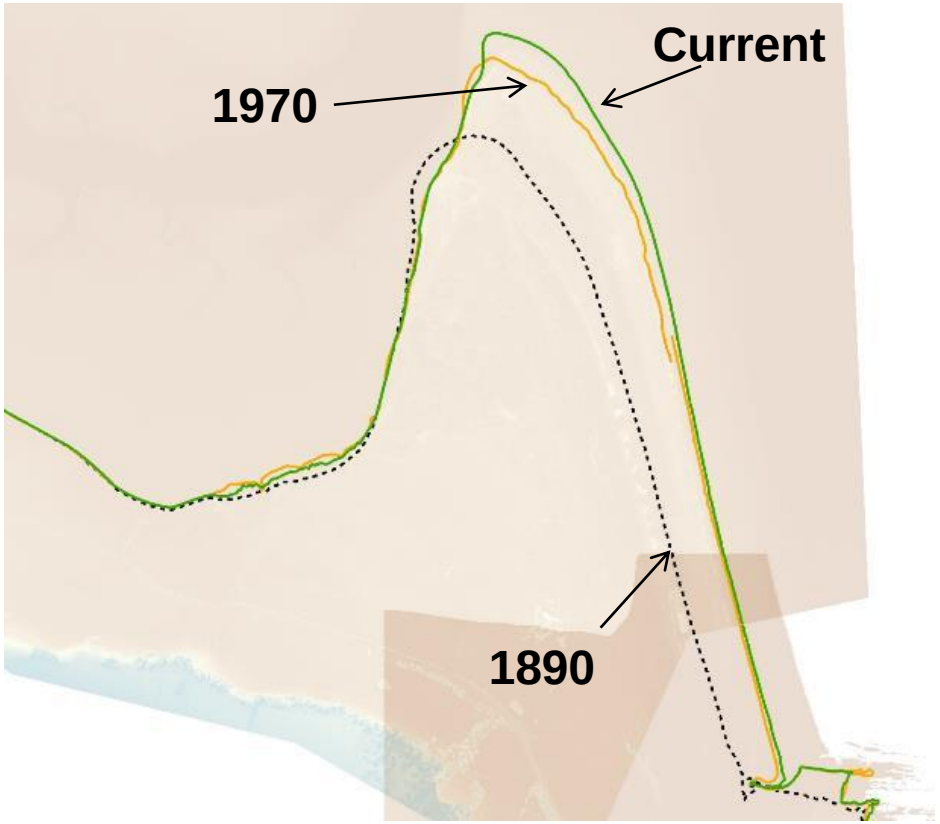
Scotland's National Coastal Change Assessment

www.dynamiccoast.com

(project partners and funder)

How do we appreciate past erosion?

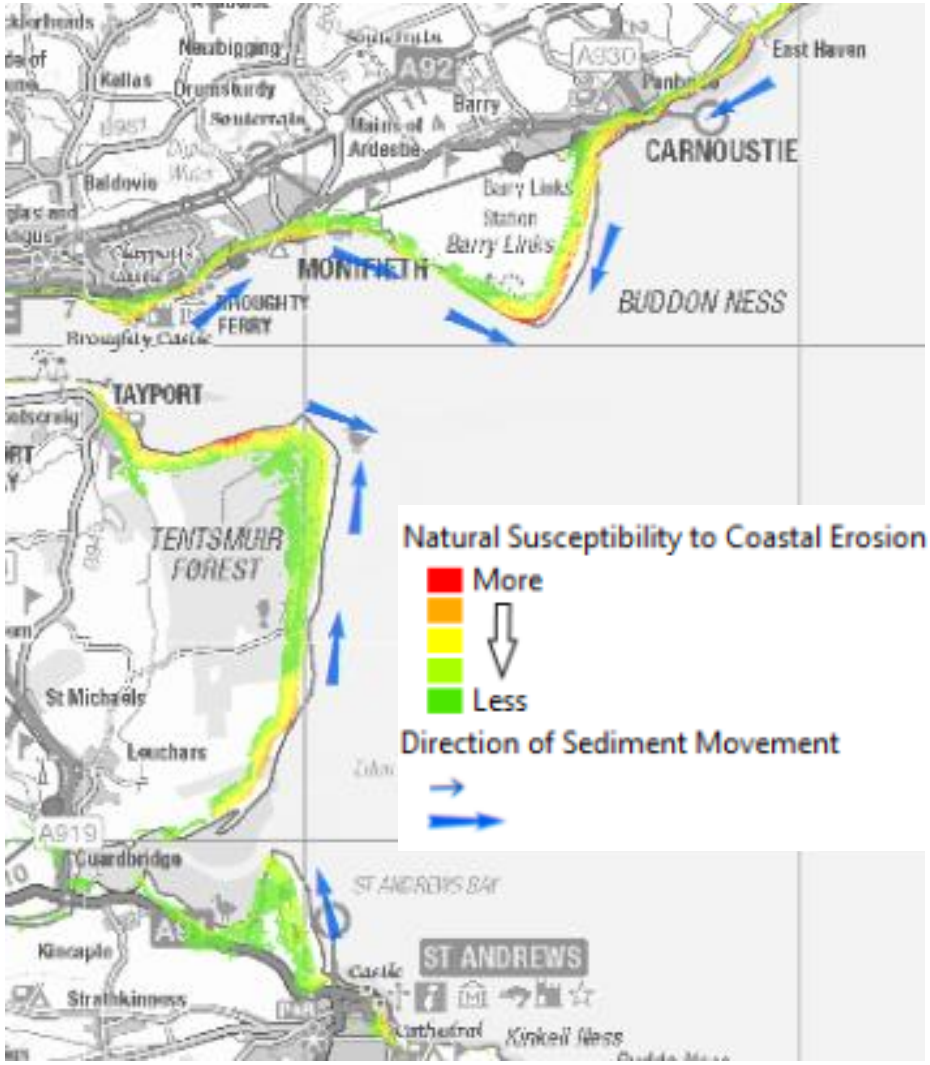
- Time series comparison of geo-rectified historical and modern mapping allows past rates of change to be established
- These are projected forward to consider future implications
- Past ≠ Future? But it is the *'least worst method'* least likely to be challenged legally
- This underpins Shoreline Management Plans (where they exist). But erosion only projected within erodible land.



(St Andrews)

Coastal Erosion Susceptibility Model

- Surface altitude, rockhead altitude, coastal proximity, wave exposure, sediment supply.
- *'inherently susceptible to erosion'*
- Used in SEPA's flood maps.



(SEPA's flood maps, UoG & SNH research. Funded by Crew)

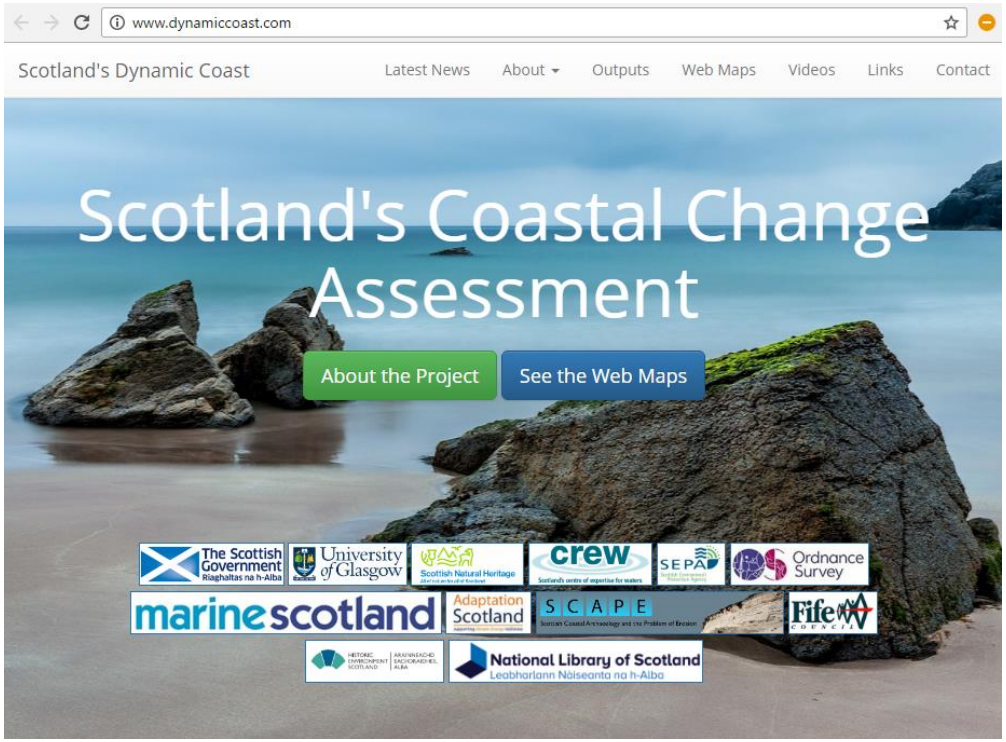
Complexities

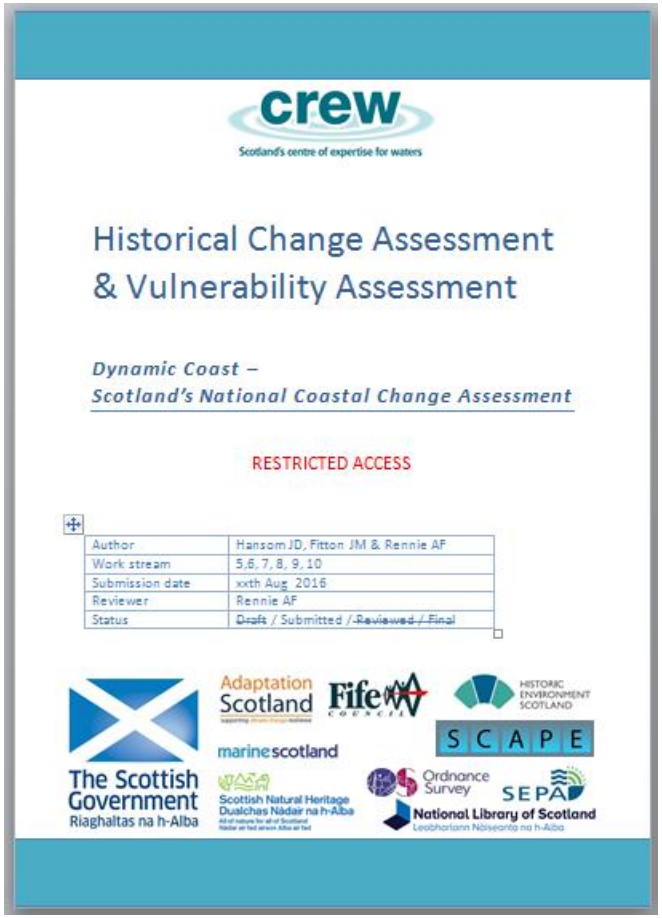
- Where is the soft coast? …. We checked all 21,000 km of shoreline.
- Is the OS mapping right? …. We checked all 4,000 km of soft coast.

  …. 17% was out of date. They've re-flown much of it!
- We've used LiDAR to update MHWS.
- Terabytes of data analyzed to appreciate our dynamic coast
- 50 project partners … *'all of society's interests'* (?)

Results … what format?

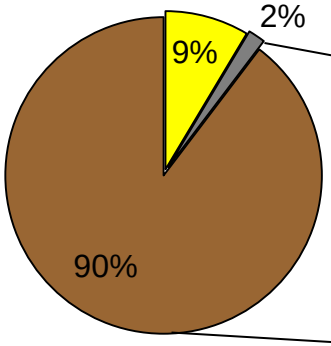
- Webmaps … DynamicCoast.com
- Reports … Cell Report detailing significant change
- Bespoke Result and Policy Reviews for key partners



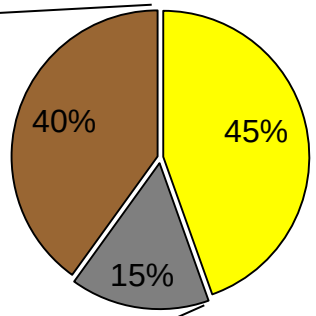


Character of Scotland's Coast

Cell 8 & 9: WI

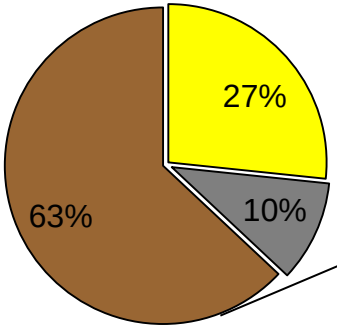


Cell 1-3: East Coast

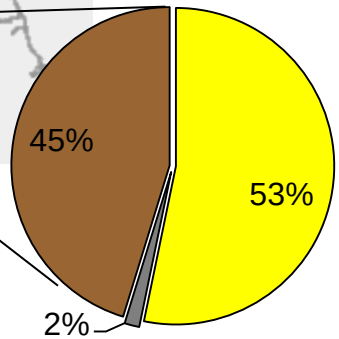


Soft
Artificial
Hard and Mixed

Cell 6: Clyde



Cell 7: Solway

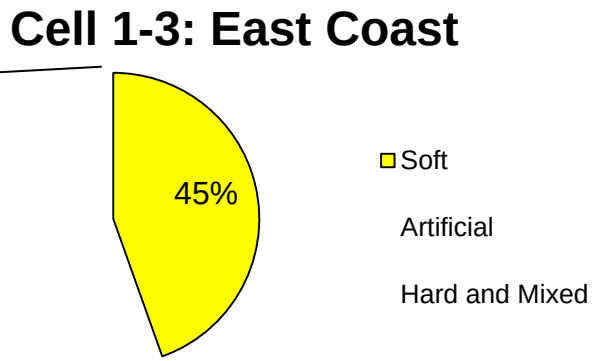


(Source)

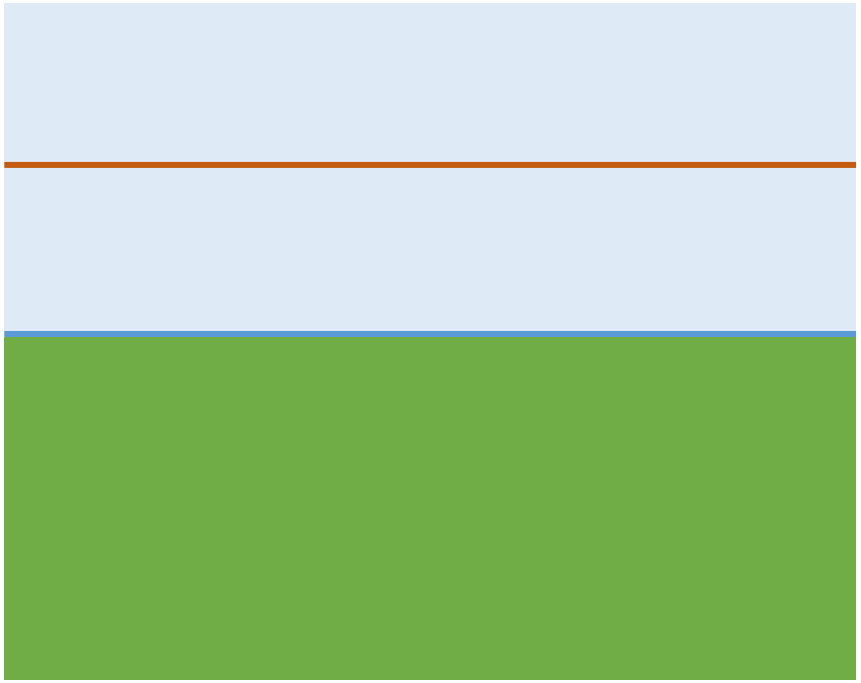
Character of Scotland's Coast

What have we done?

On every soft coast…

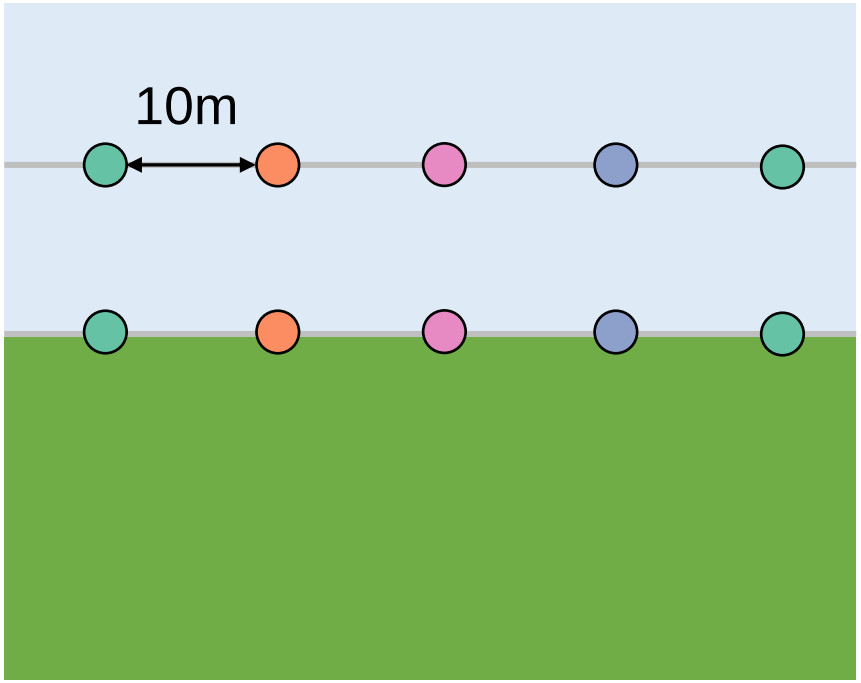


Old shoreline and current soft shoreline are plotted…



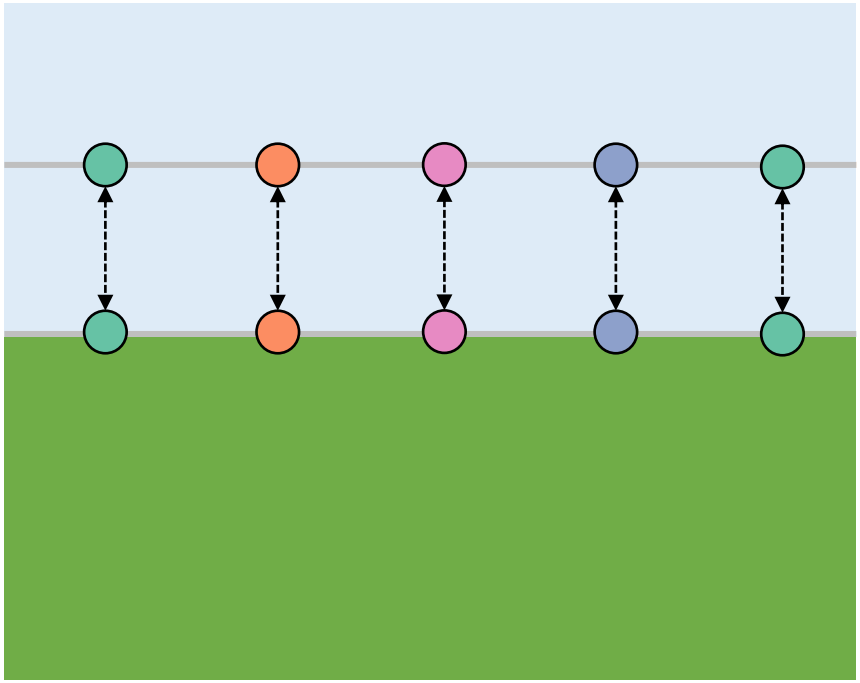
Coastal Change Rate = Distance/Time

And points are located at every 10m



Coastal Change Rate = Distance/Time

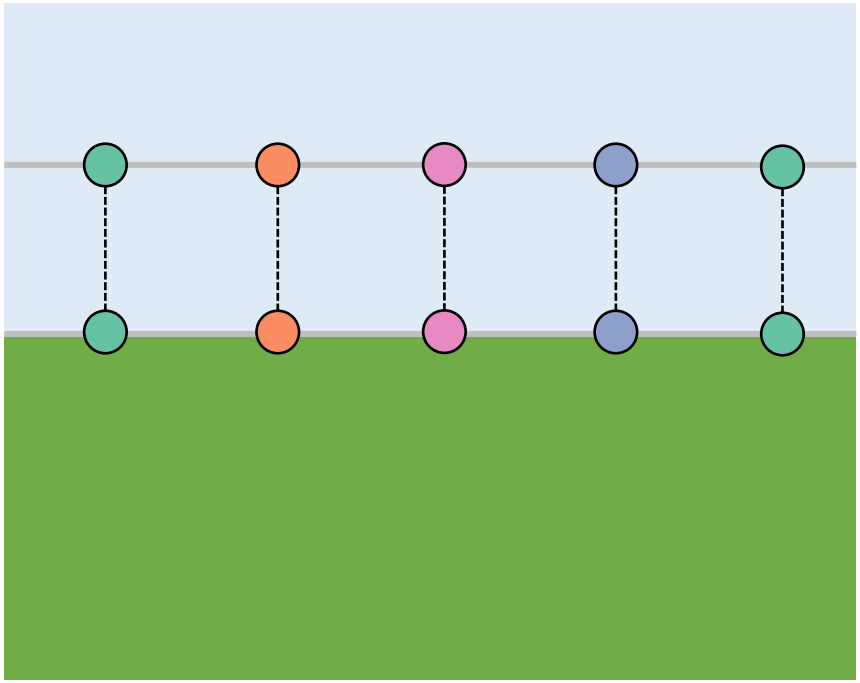
Each point on the old line then measures the distance to the new line



Coastal Change Rate = Distance/Time

Erosion is shown as a negative value

Accretion is shown as a positive value



Older Coastline

Current Coastline

Coastal Change Rate = Distance/Time

East Coast Historical Change Assessment

Coastal Cell	Overall change (1)			Advance (2)				Retreat (3)				Insignificant change (4)		
	Average 1890 to 1970 Change on Soft Coast (m)	Average 1890 to 1970 Change Rate on Soft Coast (m/year)	Length of Soft Coast (km)	Average 1890 to 1970 Soft Coast Advance (m)	Average 1890 to 1970 Advance Rate on Soft Coast (m/year)	Length of Soft Coast Advance (km)	Area of Soft Coast Advance (hectares)	Average 1890 to 1970 Soft Coast Retreat (m)	Average 1890 to 1970 Retreat Rate on Soft Coast (m/year)	Length of Soft Coast Retreat (km)	Area of Soft Coast Retreat (hectares)	Average 1890 to 1970 Soft Coast Insignificant Change (m)	Average 1890 to 1970 Retreat Rate on Soft Coast (m/year)	Length of Soft Insignificant Change (km)
Cell 1	31.6	0.37	111.7	77.8	0.91	47.1	366.6	-19.4	-0.22	9.4	18.2	0.8	0.01	55.2
Cell 2	21.2	0.03	184.9	58.9	0.71	90.9	536.0	-60.6	-0.68	25.6	154.9	1.5	0.02	68.4
Cell 3	33.4	0.45	583.6	114.0	1.54	194.4	2,251.0	-32.7	-0.45	97.5	319.4	0.7	0.01	288.5
East Coast	28.7	0.28	880.2	83.5	1.05	332.5	3,153.6	-37.6	-0.45	132.4	492.4	1.0	0.01	412.1
	-	-	-	-	-	37.8%	-	-	-	15.0%	-	-	-	46.8%

Coastal Cell	Overall change			Advance				Retreat				Insignificant change (4)		
	Average 1970 to Modern Change on Soft Coast (m)	Average 1970 to Modern Change Rate on Soft Coast (m/year)	Length of Soft Coast (km)	Average 1970 to Modern Soft Coast Advance (m)	Average 1970 to Modern Advance Rate on Soft Coast (m/year)	Length of Soft Coast Advance (km)	Area of Soft Coast Advance (hectares)	Average 1970 to Modern Soft Coast Retreat (m)	Average 1970 to Modern Retreat Rate on Soft Coast (m/year)	Length of Soft Coast Retreat (km)	Area of Soft Coast Retreat (hectares)	Average 1890 to 1970 Soft Coast Insignificant Change (m)	Average 1890 to 1970 Retreat Rate on Soft Coast (m/year)	Length of Soft Insignificant Change (km)
Cell 1	12.1	0.57	106.7	52.1	2.29	32.9	171.5	-38.8	-1.29	13.2	51.4	1.4	0.05	60.6
Cell 2	23.9	0.88	191.2	76.0	2.78	74.0	562.7	-37.6	-1.34	28.1	105.6	6.4	0.00	89.1
Cell 3	0.0	-0.03	602.9	73.5	2.26	97.3	714.9	-53.7	-1.78	133.8	719.1	0.0	0.00	371.8
East Coast	12.0	0.47	900.8	67.2	2.44	204.2	1,449.0	-43.4	-1.47	175.1	876.0	2.6	0.02	521.4
	-	-	-	-	-	22.7%		-	-	19.4%		-	-	57.9%

Within the soft sections of the East Coast, **38%** has been advancing between 1890 and 1970; compared with **23%** between 1970 and modern data.
Within the soft sections of the East Coast, **15%** has been retreating between 1890 and 1970; compared with **19%** between 1970 and modern data.

Within the soft sections of the East Coast, the average rate of advance is **1.1 m/yr** between 1890 and 1970, and **2.4 m/yr** between 1970 and modern data.
Within the soft sections of the East Coast, the average rate of retreat is **-0.5 m/yr** between 1890 and 1970, and **-1.5 m/yr** between 1970 and modern data.

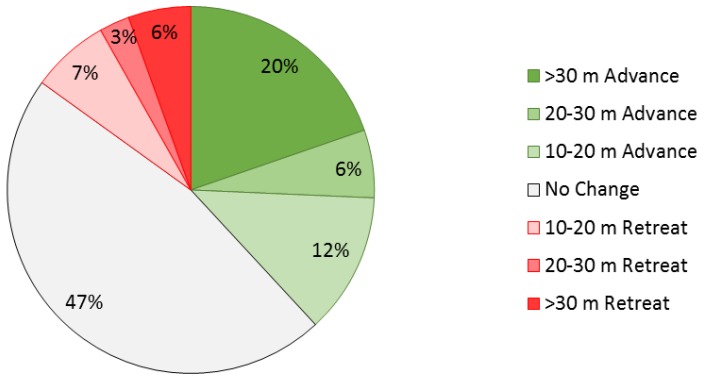
Within the soft sections of the East Coast, **47%** has not changed significantly between 1890 and 1970; compared with **58%** between 1970 and the modern data.

East Coast Historical Change Assessment

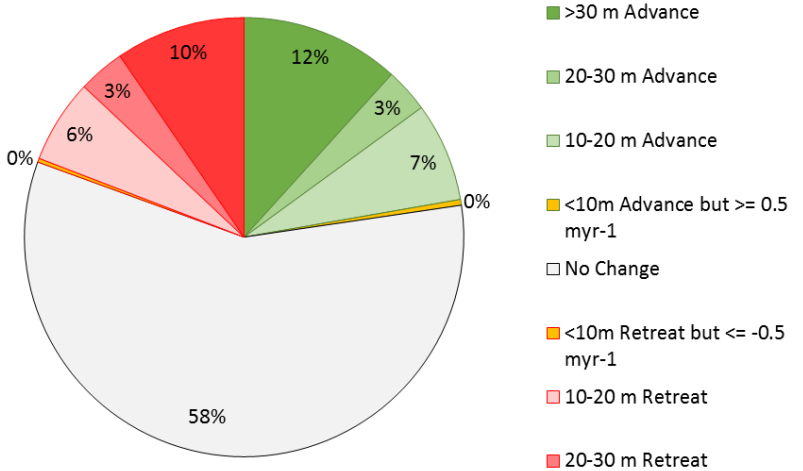
1890-1970	East Coast		Cell 1		Cell 2	
	Length (km)	Length (%)	(km)	(%)	(km)	(%)
>30 m Advance	173.6	20%	25.5	3%	48.6	6%
20-30 m Advance	52.6	6%	7.2	1%	16.3	2%
10-20 m Advance	109.4	12%	14.5	2%	26.0	3%
No Change	412.1	47%	55.2	6%	68.4	8%
10-20 m Retreat	60.6	7%	7.4	1%	11.8	1%
20-30 m Retreat	23.5	3%	0.9	0%	4.7	1%
>30 m Retreat	48.4	6%	1.1	0%	9.1	1%
Total length	**880.1**	**100%**	**111.7**	**13%**	**184.9**	**21%**

1970-Modern	East Coast		Cell 1		Cell 2	
	Length (km)	Length (%)	(km)	(%)	(km)	(%)
>30 m Advance	105.5	12%	10.0	1%	43.9	5%
20-30 m Advance	29.2	3%	6.4	1%	9.3	1%
10-20 m Advance	65.7	7%	15.8	2%	19.5	2%
<10m Advance but >= 0.5 myr^{-1}	3.8	0%	0.6	0%	1.4	0%
No Change	521.4	58%	60.6	7%	89.1	10%
<10m Retreat but <= -0.5 myr^{-1}	2.5	0%	0.2	0%	0.5	0%
10-20 m Retreat	55.6	6%	4.4	0%	10.3	1%
20-30 m Retreat	30.9	3%	2.4	0%	6.0	1%
>30 m Retreat	86.1	10%	6.2	1%	11.3	1%
Total length	**900.8**	**100%**	**106.7**	**12%**	**191.2**	**21%**

Magnitude of change: East Coast, 1890 to 1970



Magnitude of change: East Coast, 1970 to Modern data



What is happening nationally?

Between 1890-1970 and 1970-Modern

Increasing % of coast stable

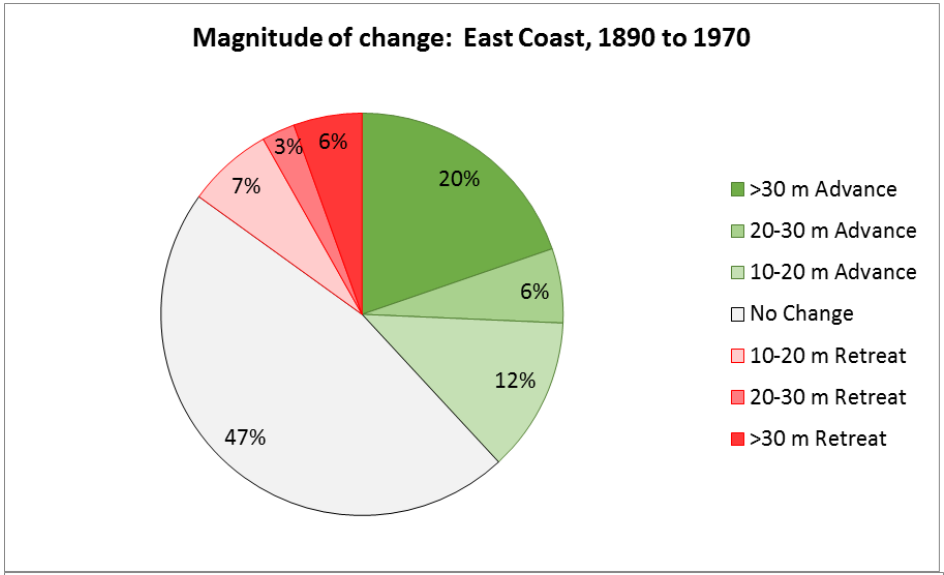
Erosion increasing in extent

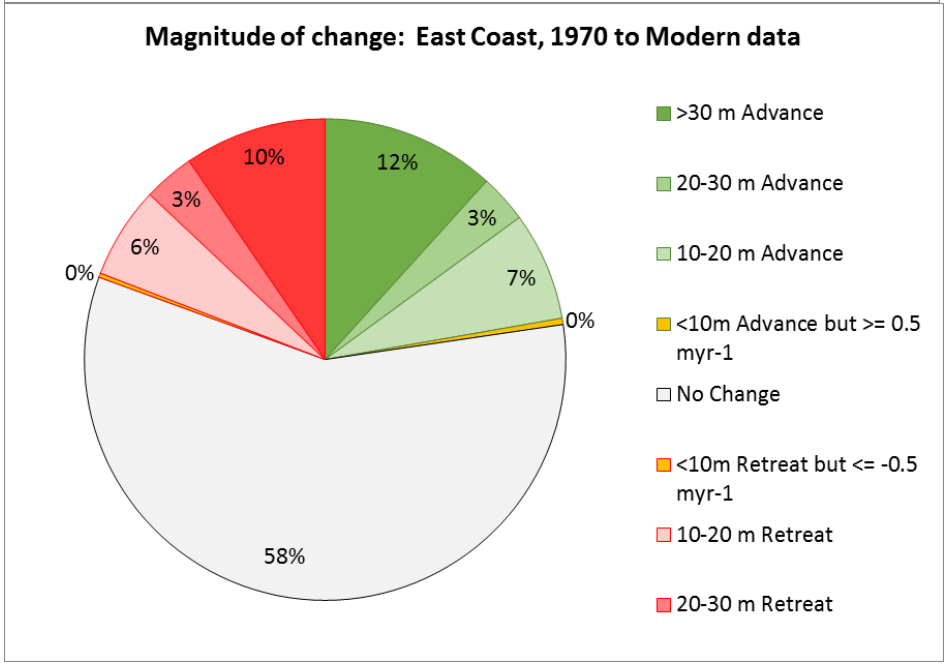
Accretion reducing in extent

More extreme erosion

Rate of erosion quickening

Rate of accretion quickening





Conclusions

- The NCCA has identified the areas experiencing rapid and modest change, and stability across Scotland's varied soft shore.

  ~ 79% of our soft coast is stable

  ~ 8% is accreting

  ~ 11% is eroding

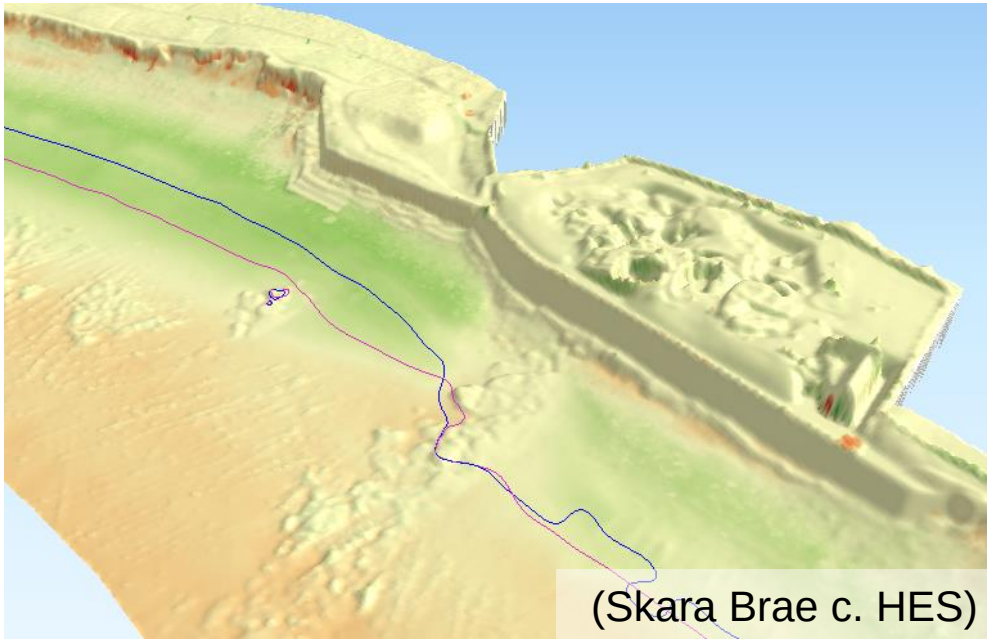
- This highlights the considerable resilience of stable and accretional areas which support strategic assessments and infrastructure planning.

- sediment @ Montrose

+ sediment @ Churchill's Barriers, Orkney

Conclusions

- *"Sustainable management of our natural capital is vital to protect essential services and economic growth in Scotland"*
- *"Nature can help us cope with Climate change".*
- Projected change highlight assets at greater risk, enabling further and more detailed assessments.
- 3D time-series analysis is required to inform detailed risk assessments, mitigation and adaptation strategies



(Skara Brae c. HES)

For further information please visit www.dynamiccoast.com

or email ncca@snh.gov.uk