

Scotland's Dynamic Coast: The National Coastal Change Assessment

Jim Hansom (UofG)

James Fitton (UofG)

Alistair Rennie (SNH)

[Find out how your coast is
changing at
www.dynamiccoast.com](http://www.dynamiccoast.com)



Presentation Outline

1. Introduction to Scottish Coast

- Why is understanding coastal change important in Scotland?

2. What is the NCCA

3. Methods

4. Results and Outcomes

5. Conclusions

Scottish coastal assets

Population

- 20% of the Scottish population live within 1 km of the coast (1 million)
- ~12 % of European coast (Pranzini and Williams 2013)
- Highly variable: resilience & assets





University
of Glasgow

Most Scottish beach and dune coasts display chronic erosion: East coastMontrose



So what drives coastal erosion?



Sea level rise



Enhanced storm impact



Reduced sediment supply



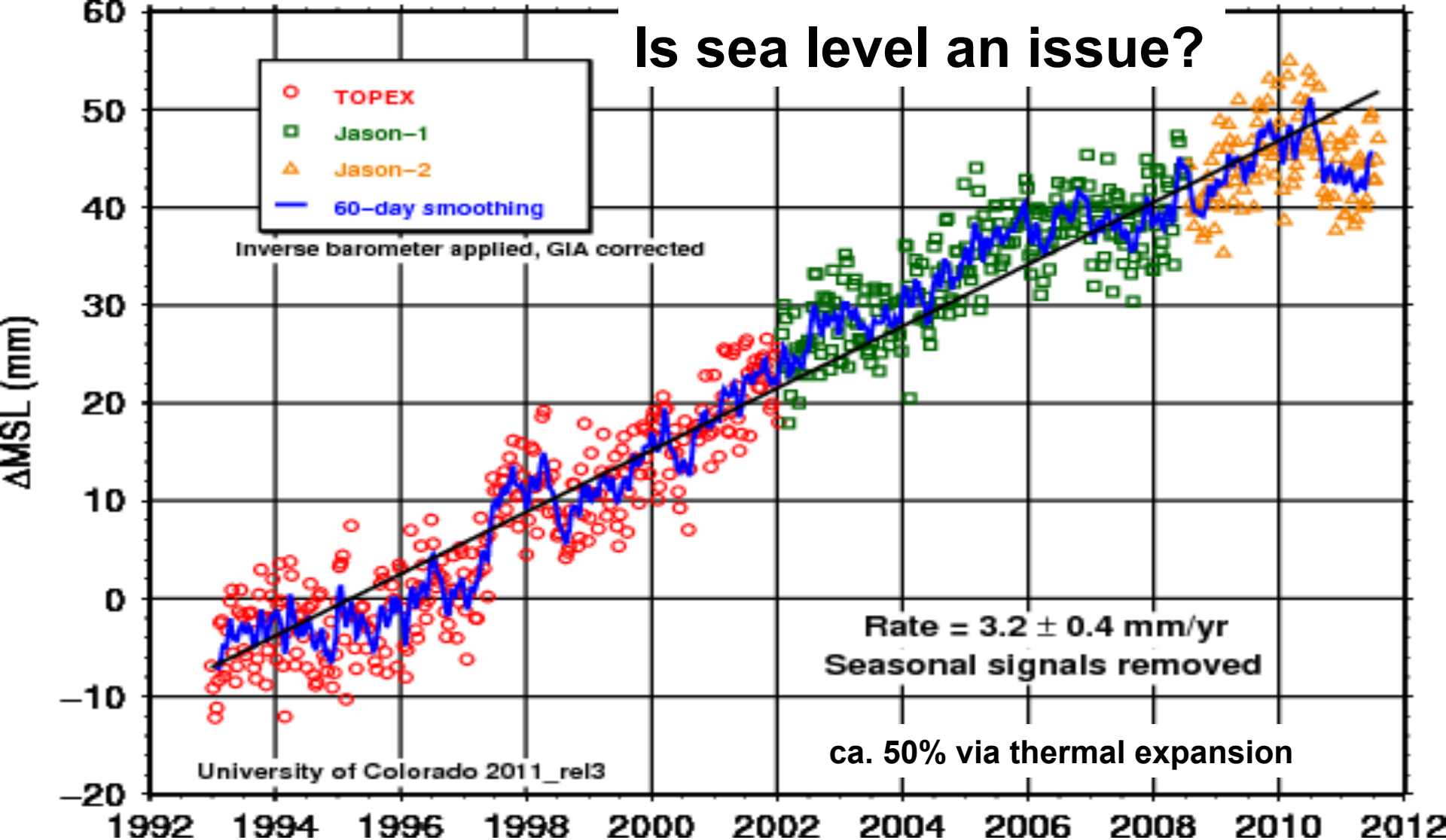
Increased “management”

Is storminess an issue?

Wave height (Hs)	Increase rate	Season	Period	Source
NE Atlantic	0.022 m/yr	Annual	1960-90	Bacon & Carter, 1991
NE Atlantic	0.027 m/yr	Annual	1960-88	Bouws et al., 1996
NE Atlantic	0.025 m/yr (min)	Annual	1955-94	Gunther et al., 1998
NW Atlantic	0.023 m/yr	Annual	1960-88	Bouws et al., 1996
NW Atlantic	0.024 m/yr	Annual	1976-06	Komar et al., 2010
NW Atlantic	0.032 m/yr	Winter	1976-06	Komar et al., 2010
NW Atlantic (Hurricanes)	0.277 m/yr	Summer	1996-05 33%inc =7.5-10m	Allen & Komar, 2009

NOTE: Table shows trend in Hs (highest 33% of all waves)
Maximum wave height (Hmax) is higher than Hs .

Is sea level an issue?



GMSL Rates

CU: 3.2 ± 0.4 mm/yr

AVISO: 3.2 ± 0.6 mm/yr

CSIRO: 3.1 ± 0.4 mm/yr

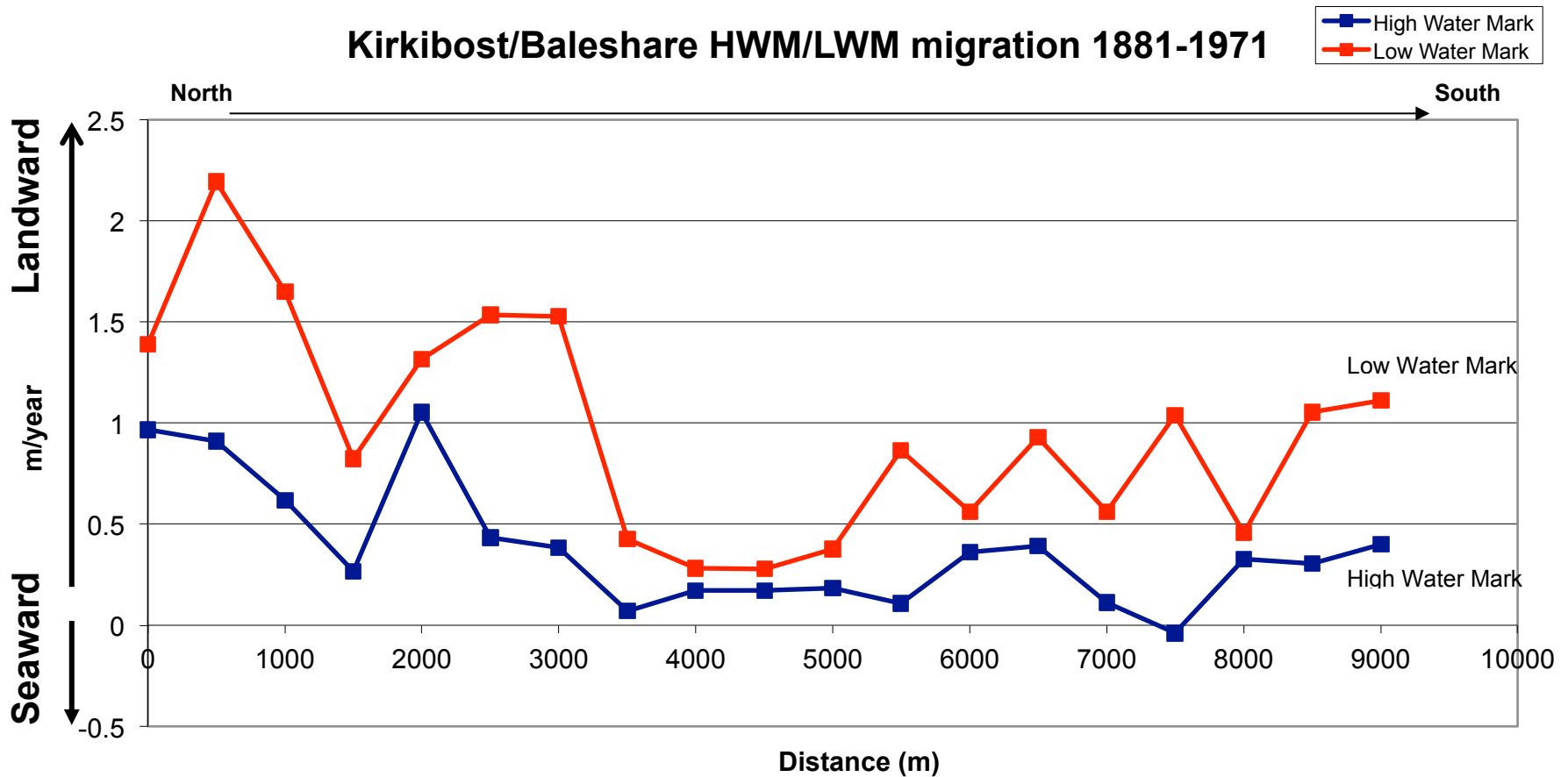
NOAA: 3.2 ± 0.4 mm/yr

1-1.5mm/yr historically 1880-1980



Is sediment supply an issue?

Kirkibost/Baleshare HWM/LWM migration 1881-1971



Hansom & McGlashan, 2004 Scotland's coast: understanding past and present processes for sustainable management, *SGJ*

Hansom, 2010 Coastal Steepening in Scotland, *SNH Report*

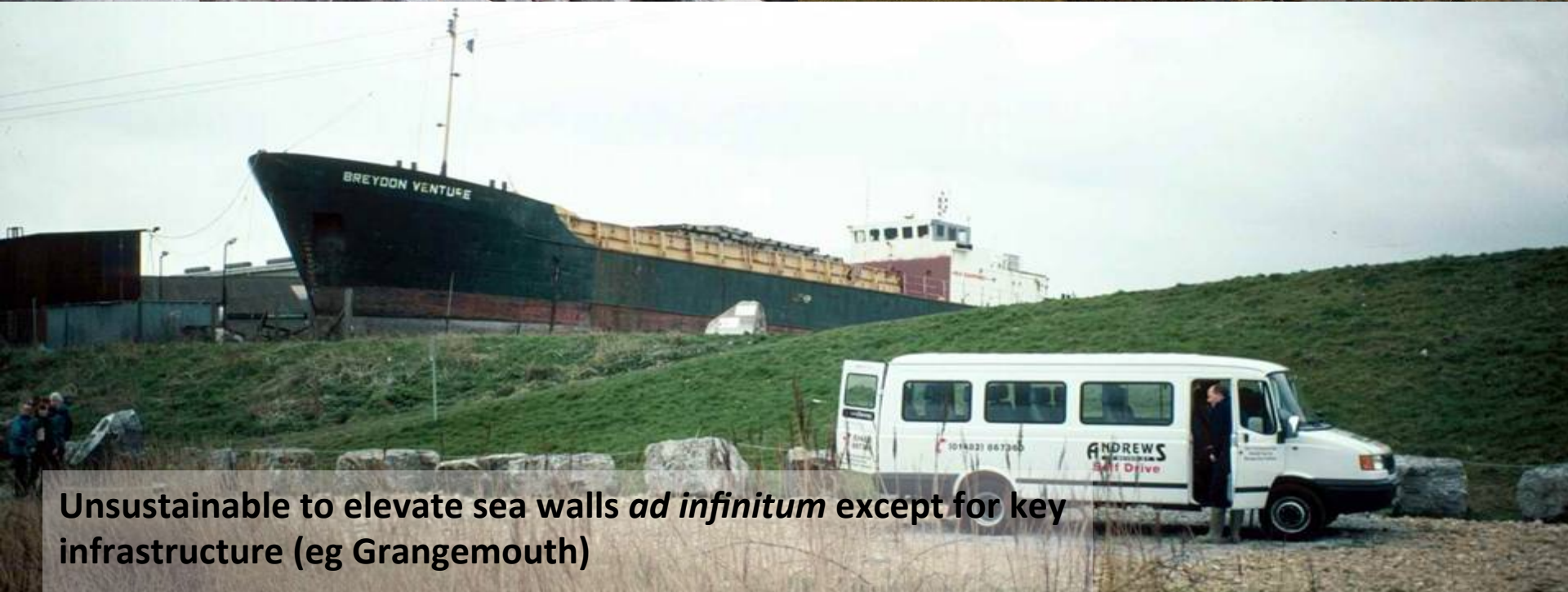
Is management an issue?



Rip rap wall, Nov 2012
Golspie, Sutherland



Rip rap wall, Jan 2013
Golspie, Sutherland

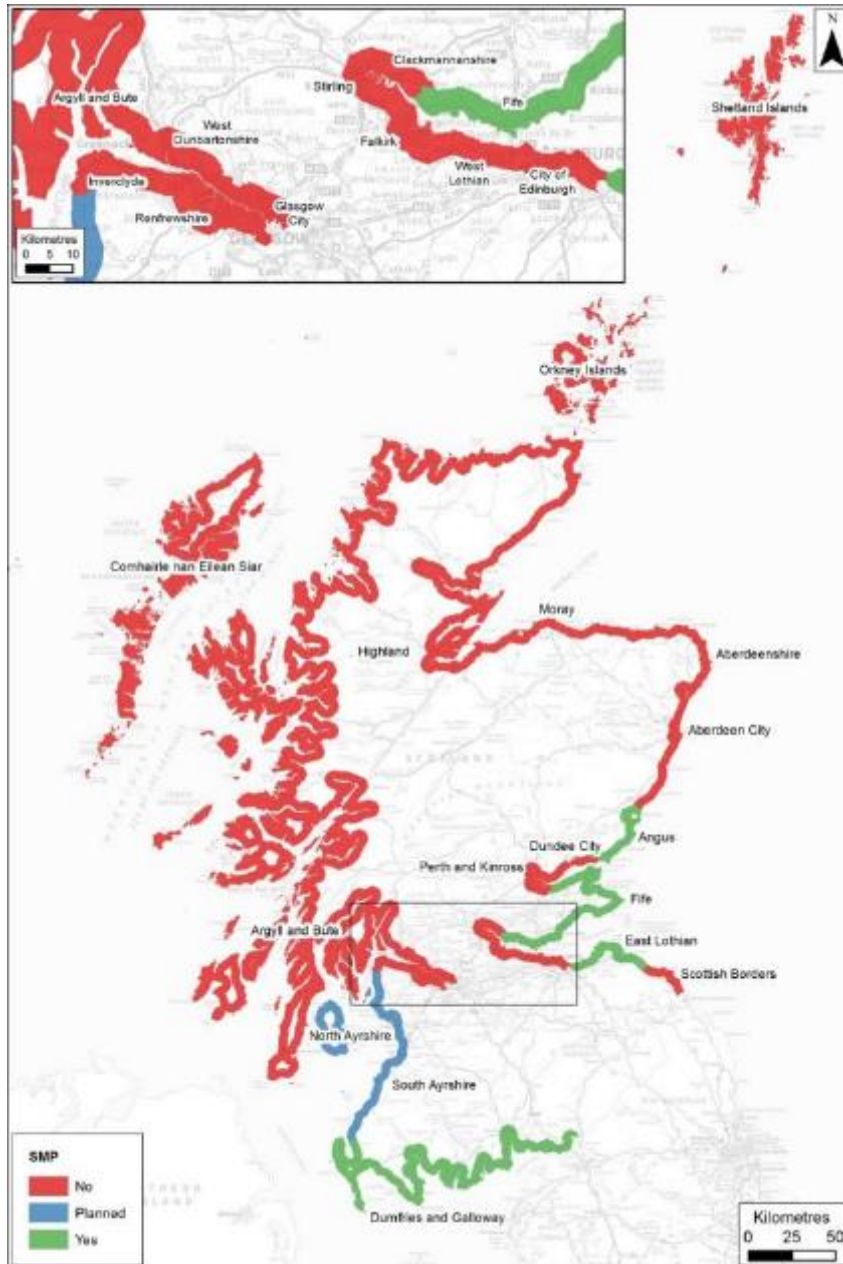


Unsustainable to elevate sea walls *ad infinitum* except for key infrastructure (eg Grangemouth)

Paradox of Coastal Erosion in Scotland

- Many organisations have an obligation to incorporate coastal erosion within their statutory advice. Yet **there is no centralised national dataset on coastal erosion** – no single organisation has responsibility.
- Part of this is due to the devolved nature of erosion, where it is the responsibility of the landowner. **The LA normally intervenes when there is a flooding concern.** This means the LA may be aware of issues, but there is no national oversight.
- Any organisation will struggle to objectively appraise the risk coastal erosion poses **to it's own interests, let alone collaborate with others.**

Current Data on Erosion



UK CCRA (2012) noted this as an evidence gap in Scotland:

‘Maps of past erosion, current state and future erosion conditions are required.’

Defra (2012) UKCCRA for Scotland - Final Report. p191

- Large parts of the Scottish coast have no Shoreline Management Plan

What's coastal erosion got to do with flooding?

Sea levels are rising across Scotland and this is already leading to increased flood occurrences. e.g. Aberdeen, Millport and Stornoway. Ball T, Werrity A, Duck RW, Edwards A, Booth L & Black AR. (2008)

Coastal flood risk in Scotland is expected to grow most rapidly in the coming decades. Estimated increase in total properties at risk for a 10% AP flood:

10% AP (10yr)	Fluvial	Coastal	Surface Water
Current estimates	15,420	4,121	9,672
2035 estimates	18,456	6,107	12,052
Increase	3,036	1,986	2,380
% increase	19.7%	48.2%	24.6%

And this excludes erosion exacerbated flooding. SG & JBA (2014)

National Coastal Change Assessment (NCCA)

A major policy-driven pan-government research project collating data and information on historic and future coastal change.

NCCA has/will:

- Undertake a quality assessment on existing data
- Establish the past changes along Scotland's coastline
- Extrapolate the historic change into the future
- Undertake an initial assessment of societies' interests within these areas (road, railways, houses etc.)
- Review national and regional coastal policies



Enable Strategic Planning

Who is involved?



50+ organisations are involved in the development of the project, and will also have access to the outputs.

Who is involved?

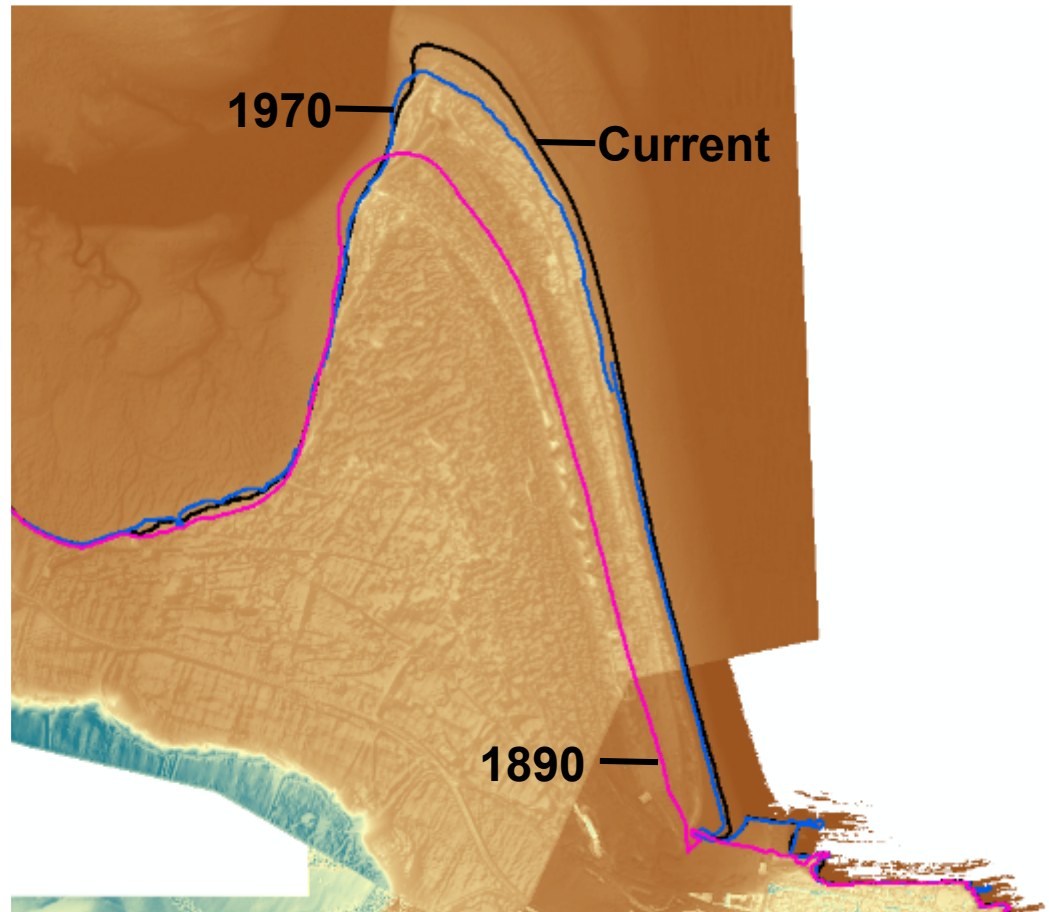
Aberdeen City Council
Aberdeenshire Council
Adaptation Scotland
Angus Council
Argyll and Bute Council
BGS
Clackmannanshire Council
Clyde Forum
CnES
CREW
Crown Estates
Dept of Envi, NI
Dumfries & Galloway Council
Dundee City Council
East Lothian Council
Edinburgh City Council
Falkirk Council
Fife Council

FCERM.net
Forth Estuary Forum
Glasgow City Council
Herriot Watt University
Highland Council
Historic Scotland
Inverclyde Council
Keep Scotland Beautiful
Marine Scotland
MoD
Moray Firth Partnership
Moray Council
N.Ayrshire Council
National Library of Scotland
Orkney Islands Council
Ordnance Survey
Perth and Kinross Council
RCAHMS

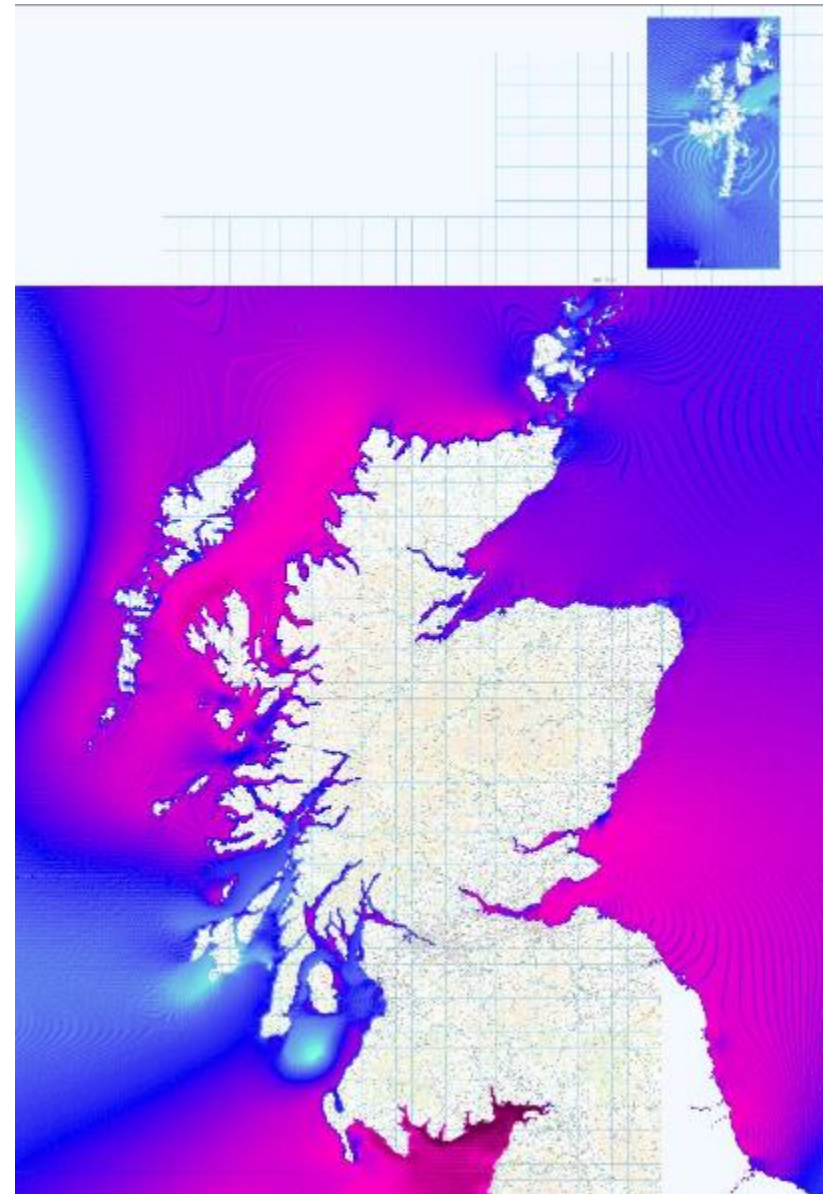
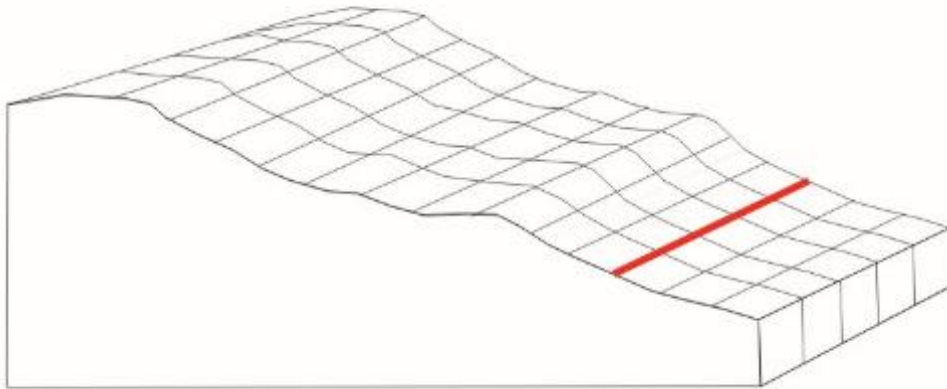
Renfrewshire Council
RSPB
S.Ayrshire Council
Scottish Borders Council
Scottish Coastal Forum
Scottish Government
SEPA
Scottish Golf Environment Group
Scottish Golf Union
Shetland Islands Council
SNH
Solway Firth Partnership
St Andrews University
Stirling Council
Transport Scotland
University of Glasgow
West Dunbartonshire Council
West Lothian Council

NCCA Methods – Historic Change

- 1890s OS Second Edition Country Series Maps
- 1970s OS 1:10,000
- Current MHWS (derived from LiDAR/Aerial Photography)

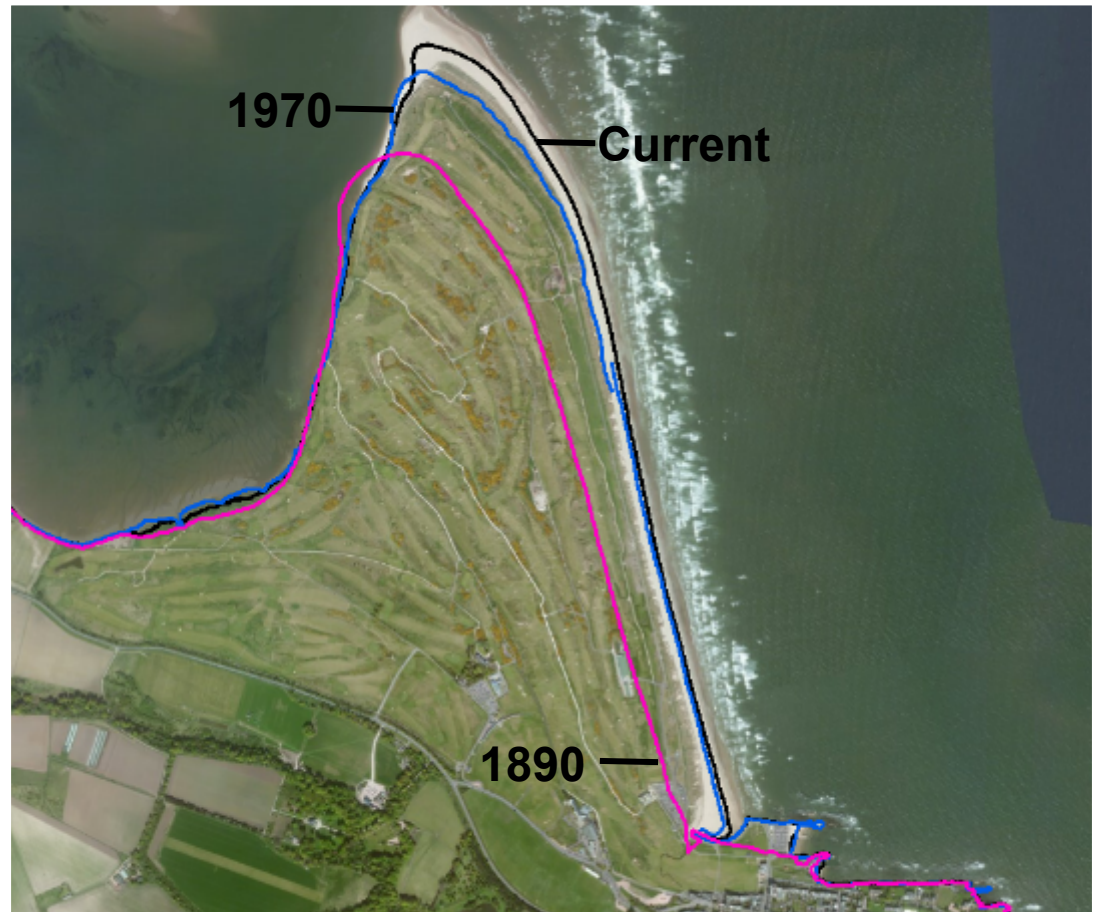


MHWS Extraction

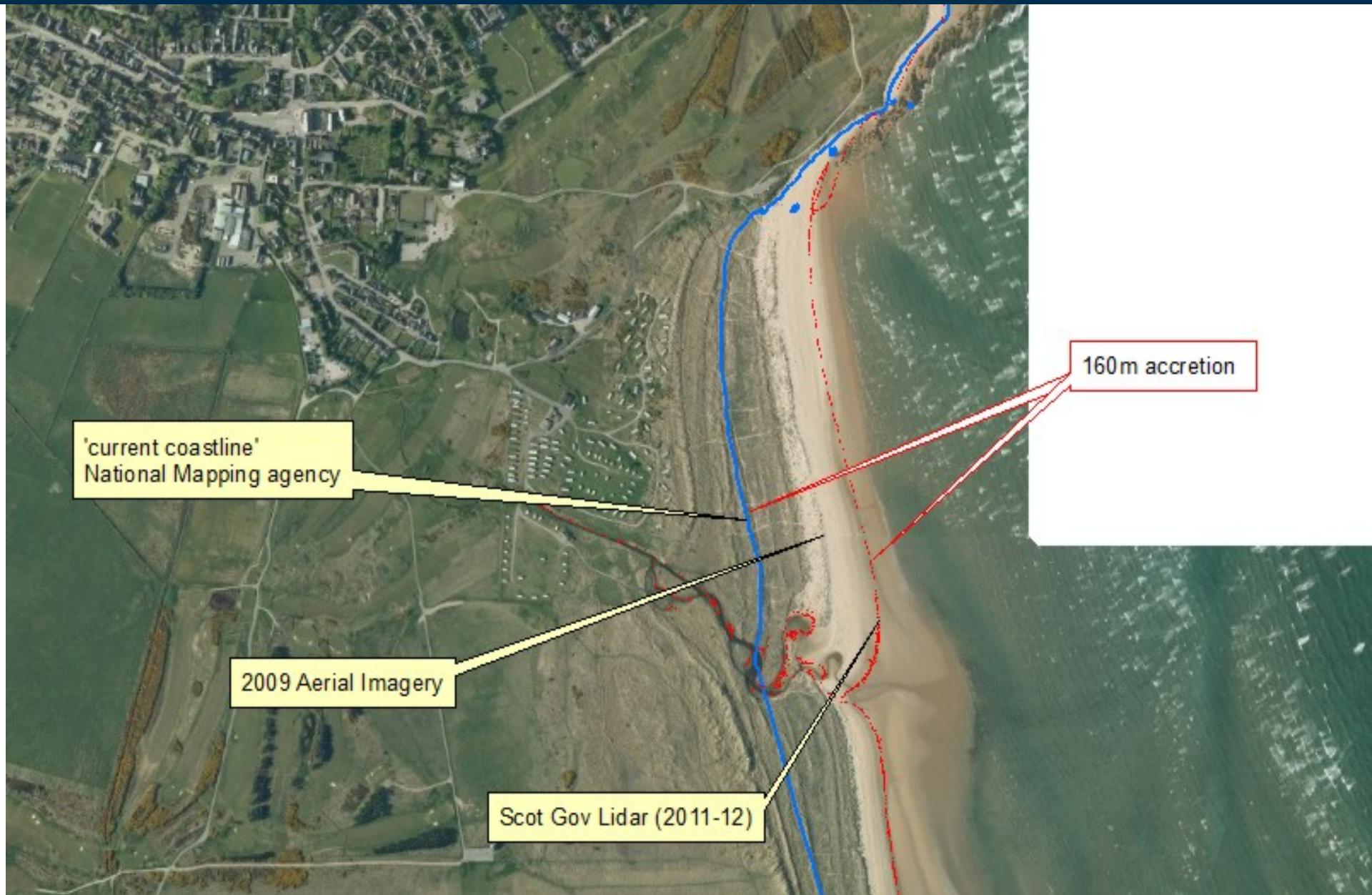


NCCA Methods – Historic Change

- 1890s OS Second Edition Country Series Maps
- 1970s OS 1:10,000
- Current MHWS (derived from LiDAR/Aerial Photography)
- Calculate the change rate between these lines (distance/time)



Use of OS MasterMap data



The NCCA has established...

- Scotland's coastline is **21,234 km** long
- **4,434 km** is soft / erodible
- SG LiDAR covers **1,710 km** of MHWS & will be used to update MHWS
- This leaves **2,724 km** which was checked to ensure it's accuracy
- Of this **2,297 km (84%)** was found to be representative
- **427 km (16%)** needed revision
- **120 km** updated using OS supplied DSMs
- **307 km** needs to be updated in the future

(all measured on OS MasterMap)

Fife – 1890s to 1970s



Fife – 1970s to Modern

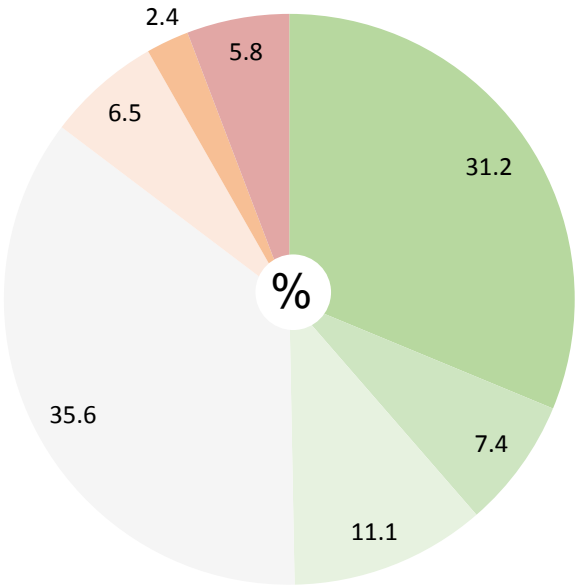


Sources: Esri, DigitalGlobe, GeoEye, IGN, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero, Samsat, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

Fife Statistics

1890s to 1970s

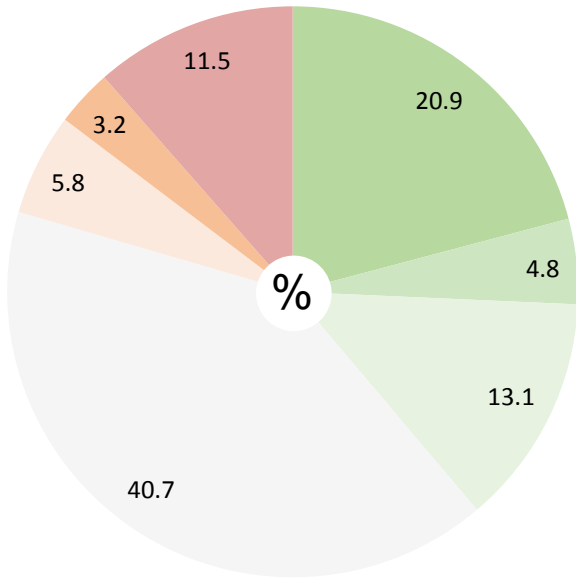
Fife Character	Length (km)	Length (%)
Hard & Mixed	74.1	33.9
Artificial	88.8	40.7
Soft	55.5	25.4
Total	218.4	100



Max Soft Advance (m)	537	North Tentsmuir
Average Soft Change (m)	25	
Max Soft Retreat (m)	556	South Tentsmuir

1970s to 2010s

Fife Character	Length (km)	Length (%)
Hard & Mixed	77.2	34.1
Artificial	87.4	38.6
Soft	61.8	27.3
Total	226.4	100

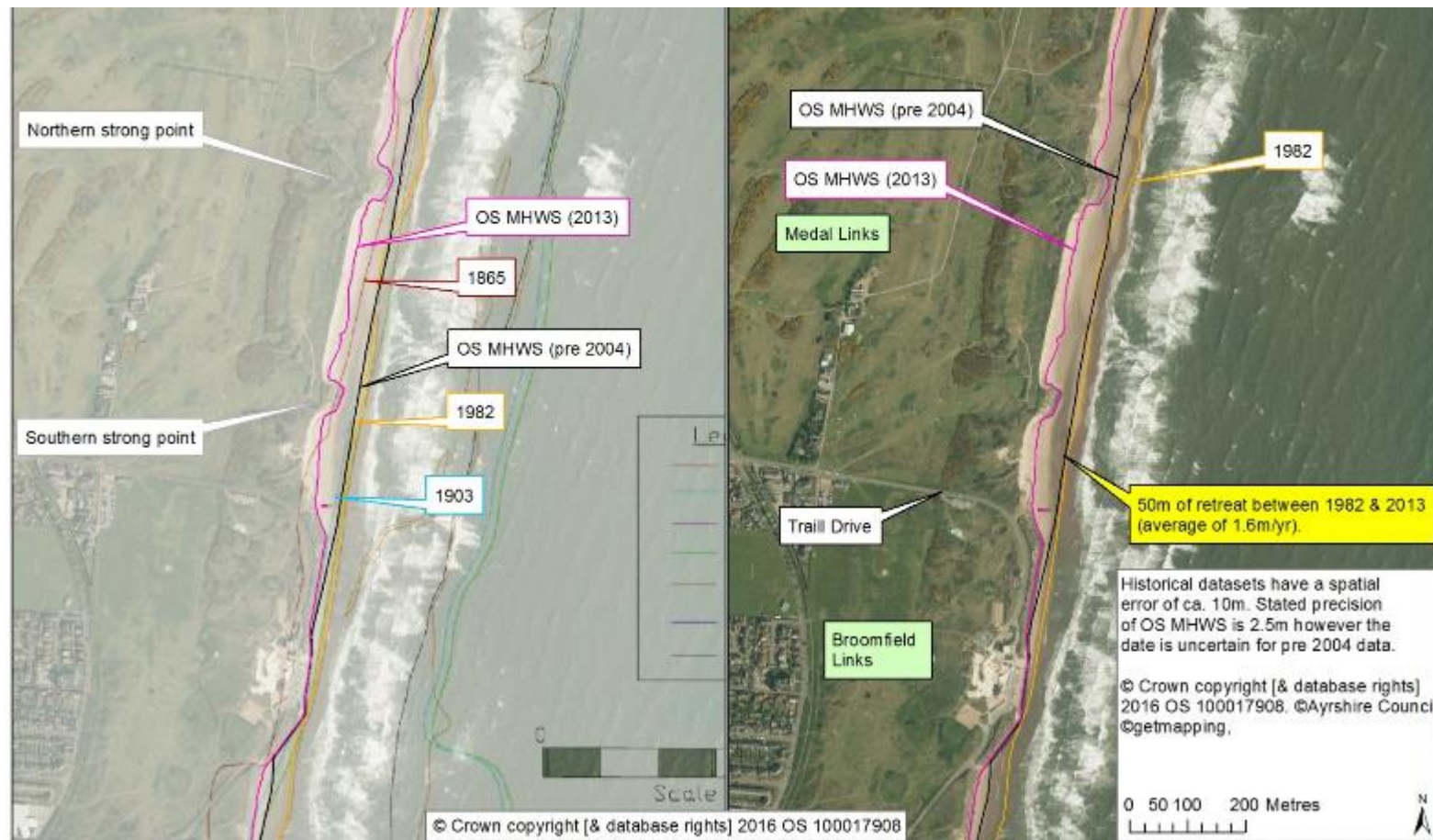


Max Soft Advance (m)	386	North Tentsmuir
Average Soft Change (m)	21	
Max Soft Retreat (m)	196	North Tentsmuir

Improving the evidence base (Montrose)

NCCA overlaid with Angus SMP

- Supporting a policy led approach to coastal management (better than reactive approach) thus supporting the LA as Coastal Protection Authorities
- Also informing Scottish Planning Policy, Flood Risk Management Strategies, Local Development Plans, Climate Change Adaptation Programme, National & Regional Marine Plans etc







Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

1991



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

2011



Change between 1991 and 2011

Interim results available online...

www.dynamiccoast.com



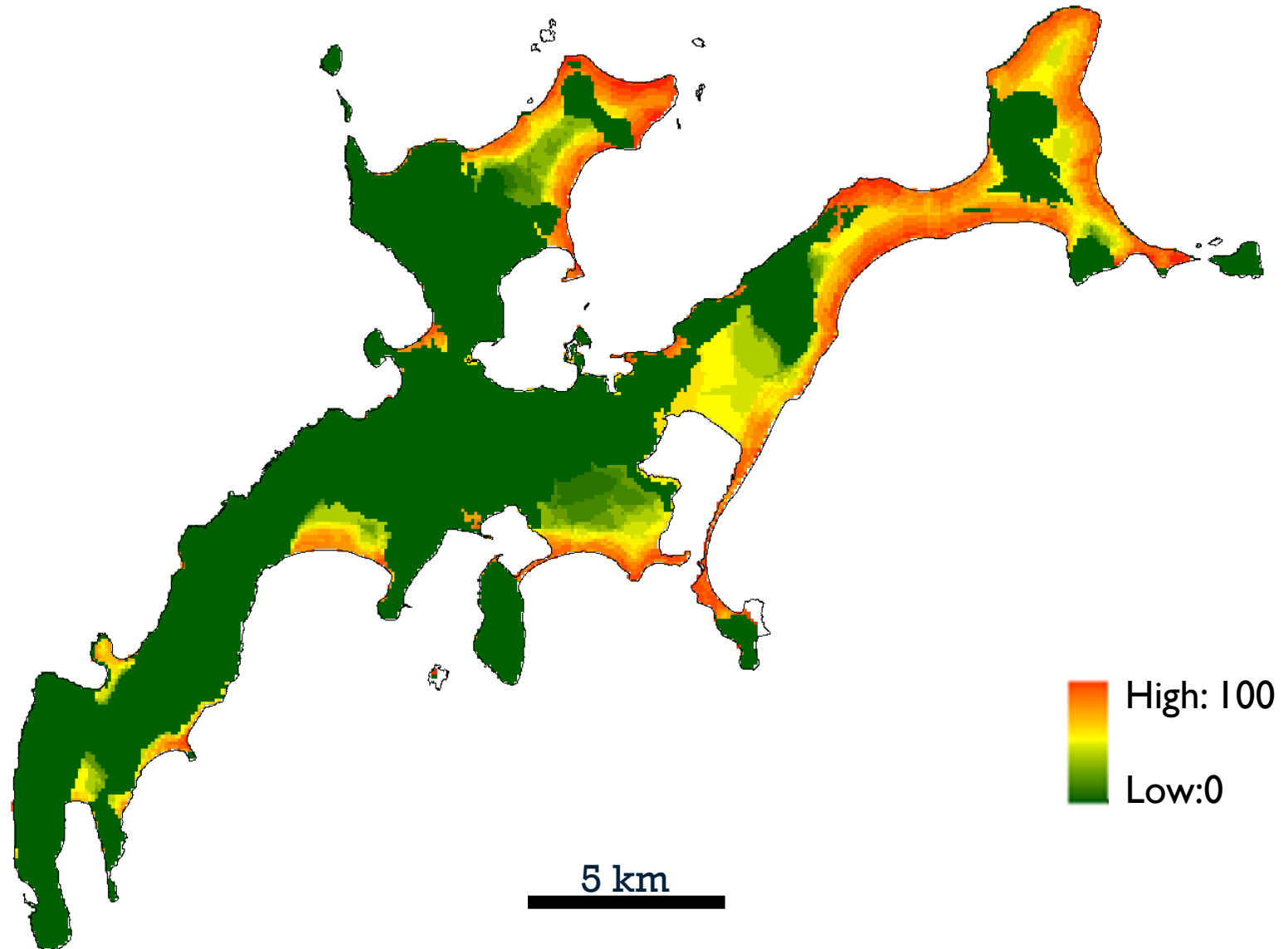
The future coast?

Future coast: 25 years (i.e. 25 x past rate)



Future coast will be amended by CESM.

Coastal Erosion Susceptibility Model (CESM)



Do we have the data to identify assets impacted by coastal erosion and target our responses?

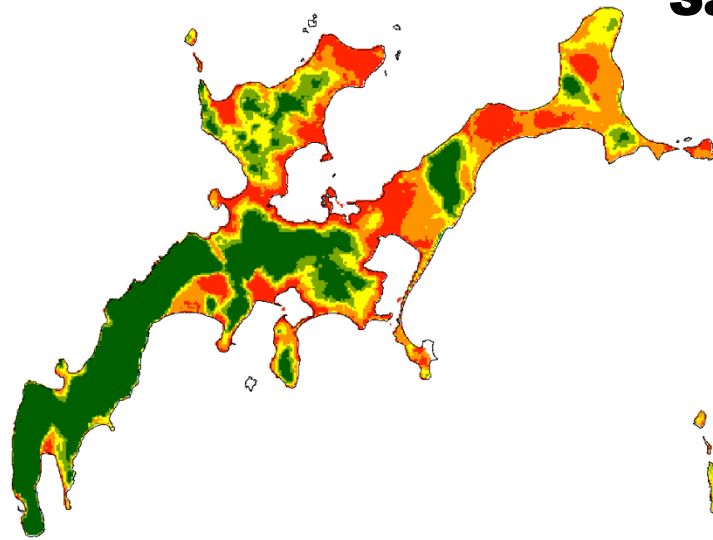
Can we model erosion susceptibility and vulnerability?

Table 8: Potential scores achieved when the four data layers of the UPSM are aggregated.

	5	4	3	2	1	Weighting
	Most susceptible				Least susceptible	
Elevation (mAOD)	5	4	3	2	1	1
Rockhead (mAOD)	5	4	3	2	1	1
Distance to open coast (m)	5	4	3	2	1	1
Wave Exposure	2.5	2	1.5	1	0.5	0.5
Aggregate Score	17.5 ☹️	14	10.5	7	3.5 😊	

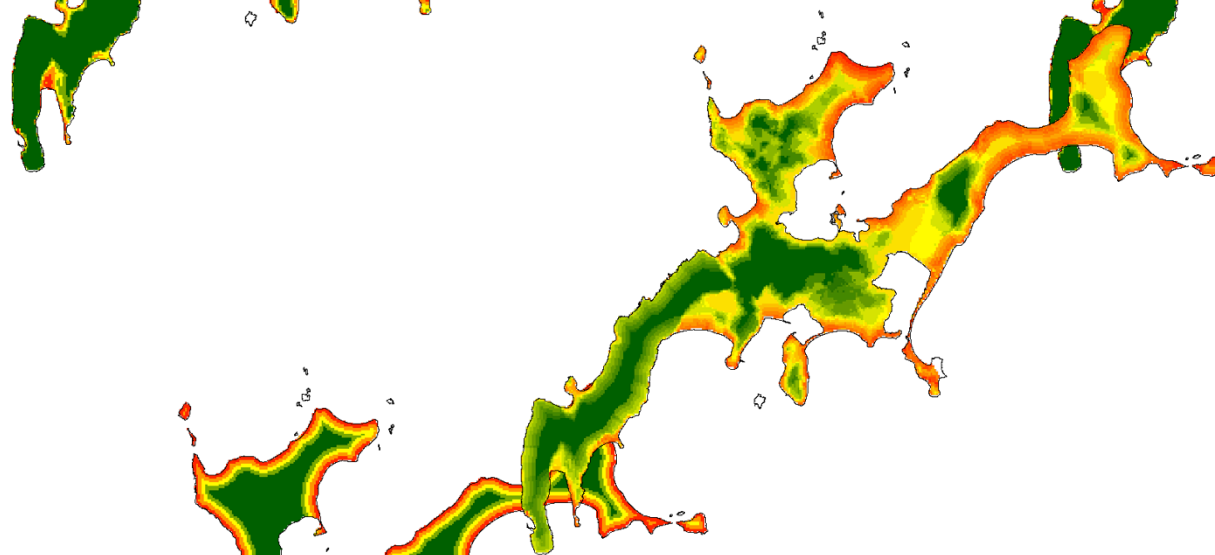
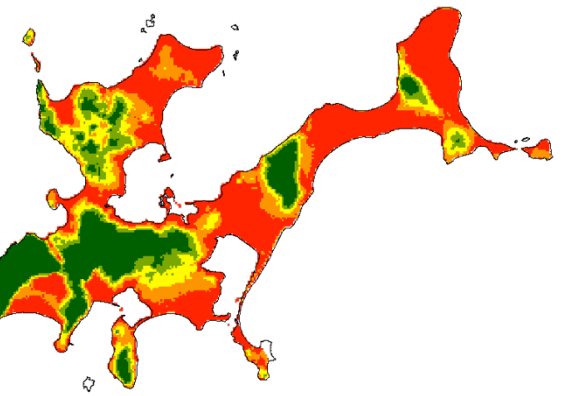
Hansom, Fitton, & Rennie, 2013. Consideration of the impacts of coastal erosion in flood risk management appraisals. CREW/SEPA Stage 1, 2, GIS. 56 + 63pp.

Elevation

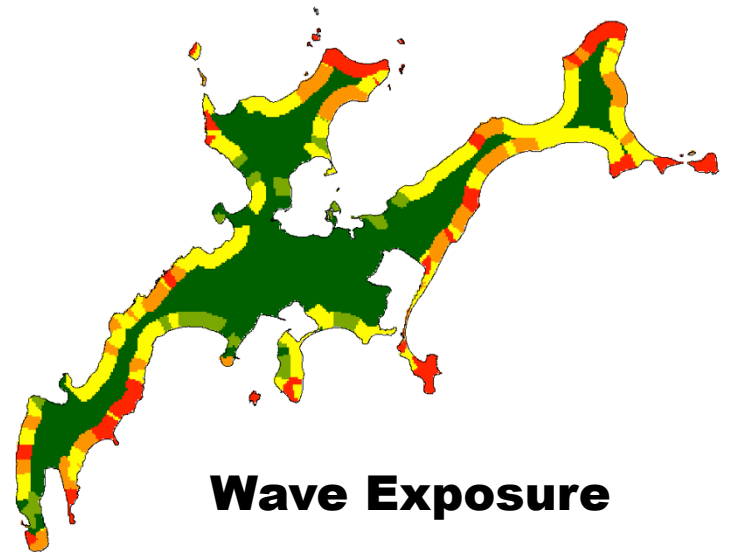


Sanday, Orkney

Rockhead

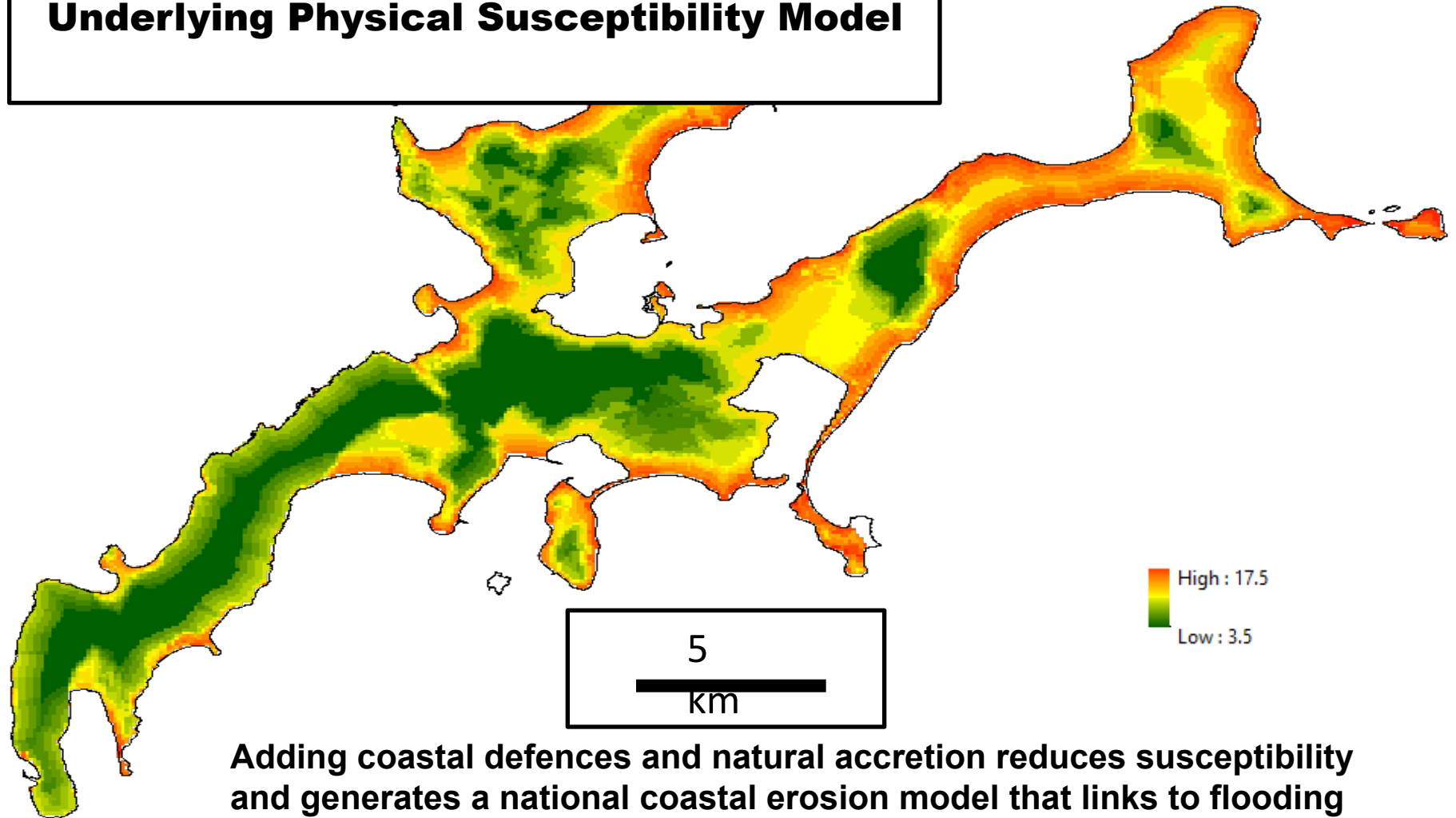


Open Coast



Wave Exposure

Underlying Physical Susceptibility Model



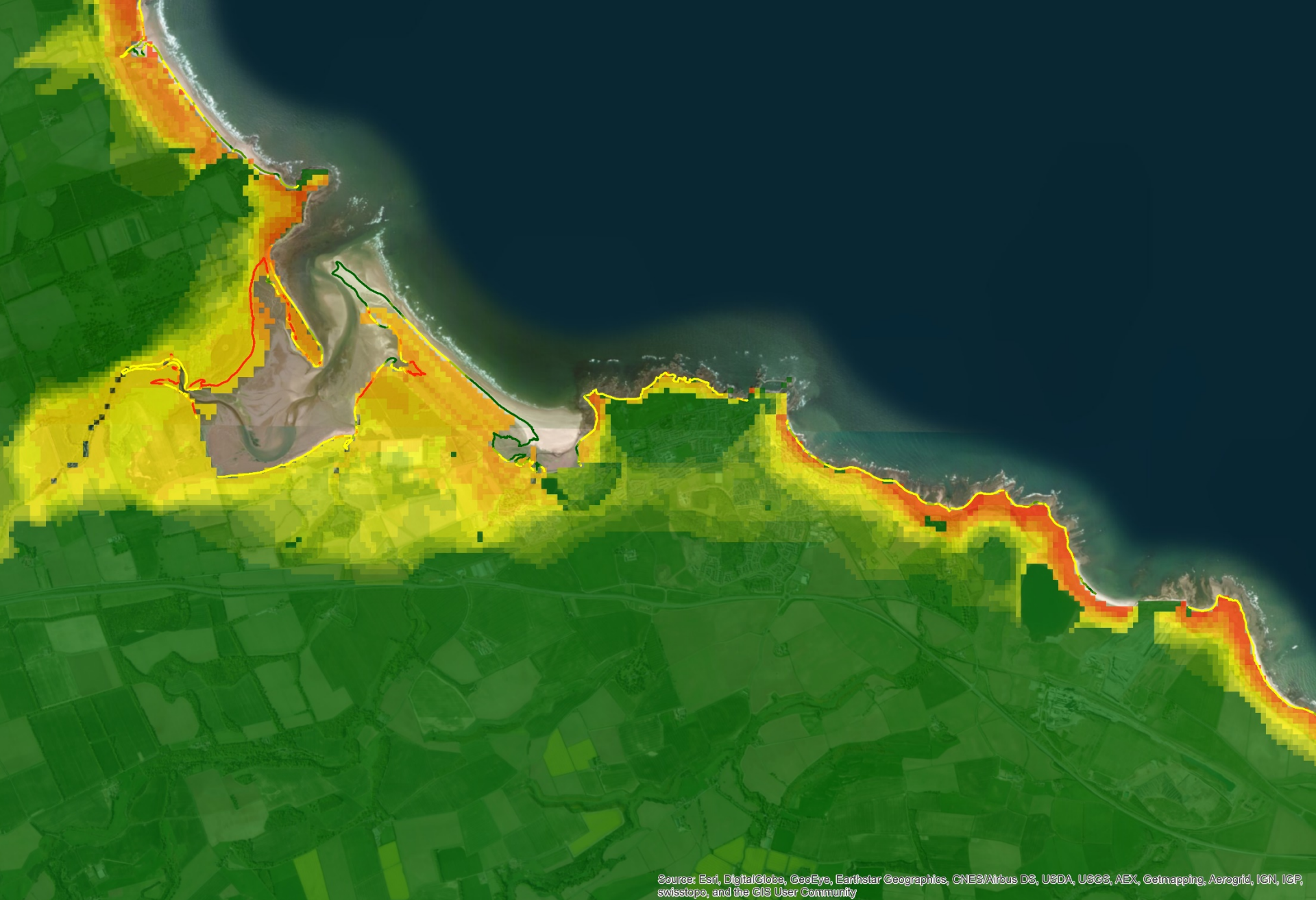
Model now part of SEPAs national coastal flood and erosion risk online maps.

Hansom, Fitton, & Rennie, 2013. Consideration of the impacts of coastal erosion in flood risk management appraisals. CREW/SEPA Stage 1, 2, GIS. 56 + 63pp.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

UPSM



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

CESM

Conclusions

- The NCCA pan-government project has **classified Scotland's erodible coast for the first time**. The project is due to finish in September 2016.
- It will **inform statutory advice across Agencies and Local Authorities** alike in support of their strategic planning individually, but also collaboratively, thereby supporting the SG Climate Change Adaptation Programme.
- It will inform areas **where erosion may influence flood risk** – currently not identified within flood mapping.
- It has prompted the first **checking & update of MHWS since the 1970s**, and has ensured that the OS can, and will, maintain this in the future.
- The NCCA has prompted the OS into revisions to their coastal mapping methods pan-UK.



www.dynamiccoast.com

jim.hansom@glasgow.ac.uk



1984



2011

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community