



Edinburgh Adapts

Coastal Workshop

20 April 2017 | Edinburgh Centre for Carbon Innovation

Edinburgh Adapts – Our Vision

Our vision is for an Edinburgh that considers:

- climate risks and opportunities at all levels of decision making
- works with the grain of our valuable natural systems,
- is resilient to the shocks of extreme weather, and,
- where citizens live healthy, happy, lives safe from the unavoidable impacts of climate change.





Edinburgh Adapts **Climate Change Adaptation Action Plan**

2016→2020



EDINBURGH WORLD HERITAGE



Edinburgh Adapts Steering Group



Royal
Botanic Garden
Edinburgh



Aim

- Find out about coastal change risks for Edinburgh
- Explore how we can respond



Agenda

- 1325-1345: Overview of coastal climate change risks for Edinburgh
- 1345-1440: Policy opportunities and barriers to coastal climate change adaptation
- 14:40-15:00 Coffee/Tea Break
- 1505-1525: Creating a social vision for future coastal climate communities
- 1525-1545: Ecosystem-based adaptation options
- 1545-1630: Way forward - discussion
- 1630-1645: Closing remarks



Coastal Climate Change Risks in Scotland

Edinburgh Coastal Adaptation Workshop
21st April 2017



Dr. James Fitton (UofG)
Dr. Jim Hansom (UofG) & Dr. Alistair Rennie (SNH)

Introduction

- **Past:** How has the Edinburgh coastline changed in last 130 years?
- **Present:** What are the current problems at the coastline?
- **Future:** What are the future issues that will need to be addressed?

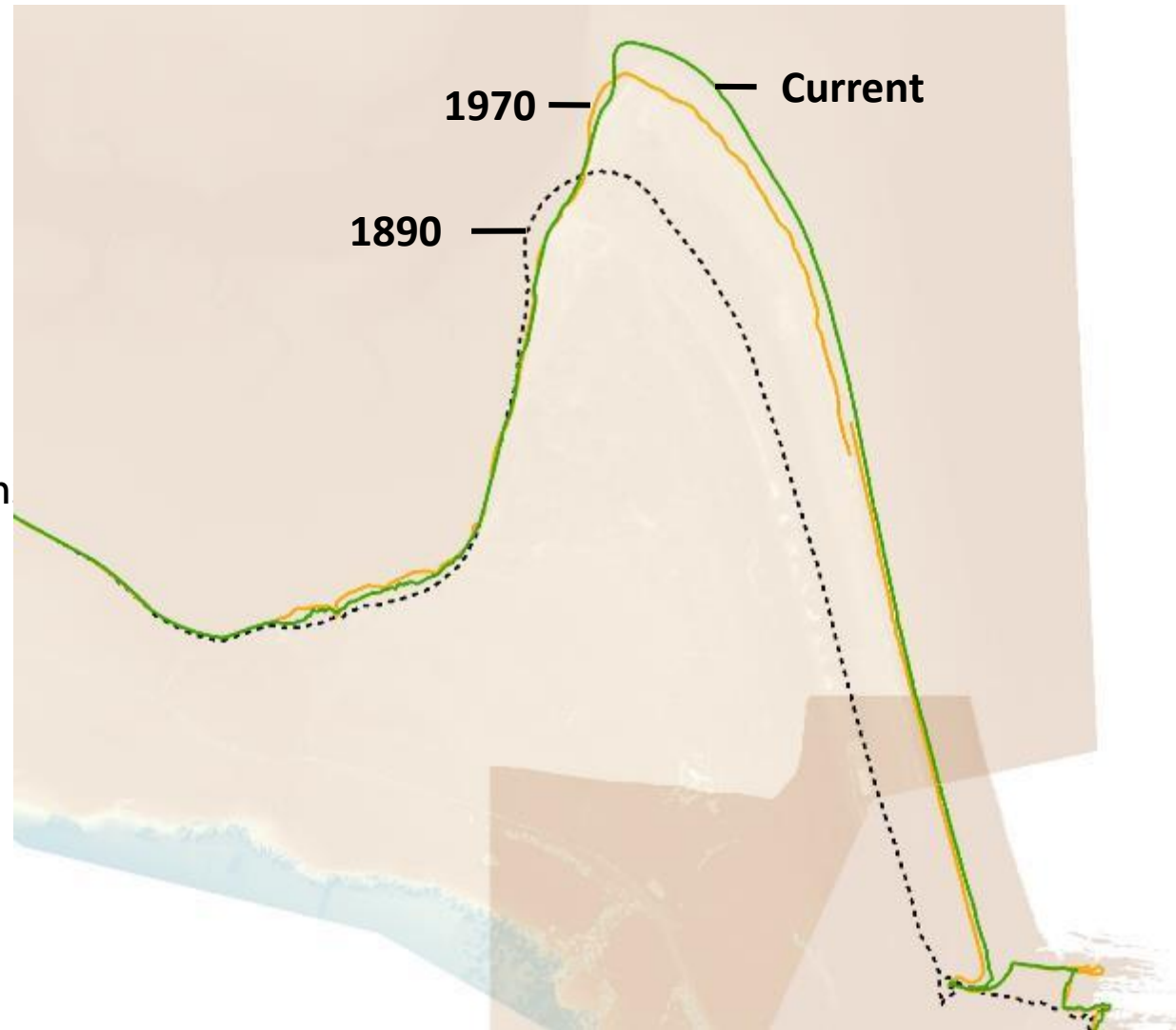
The Past...

- **The National Coastal Change Assessment (NCCA)**
- **An initial national-level assessment of historical and recent coastal change, to identify society's assets at increased risk from coastal erosion, based on existing nationally available datasets.**
- **Webmaps and reports available at www.dynanmiccoast.com**



Extract tide line & analyse

- **1890s** OS 6 Inch Second Edition Country Series Maps (NLS)
- **1970s** OS 1:10,000 (NLS)
- **Current** MHWS derived from
 - QA'ed OS published data
 - LiDAR
 - Aerial photography
 - TLS



Cramond

1975

2015

120 m

1895

Kilometres

0 0.075 0.15



Muirhouse/Granton

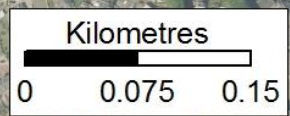


Leith



Seafield Sewage Works

360 m



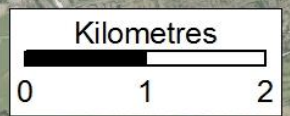
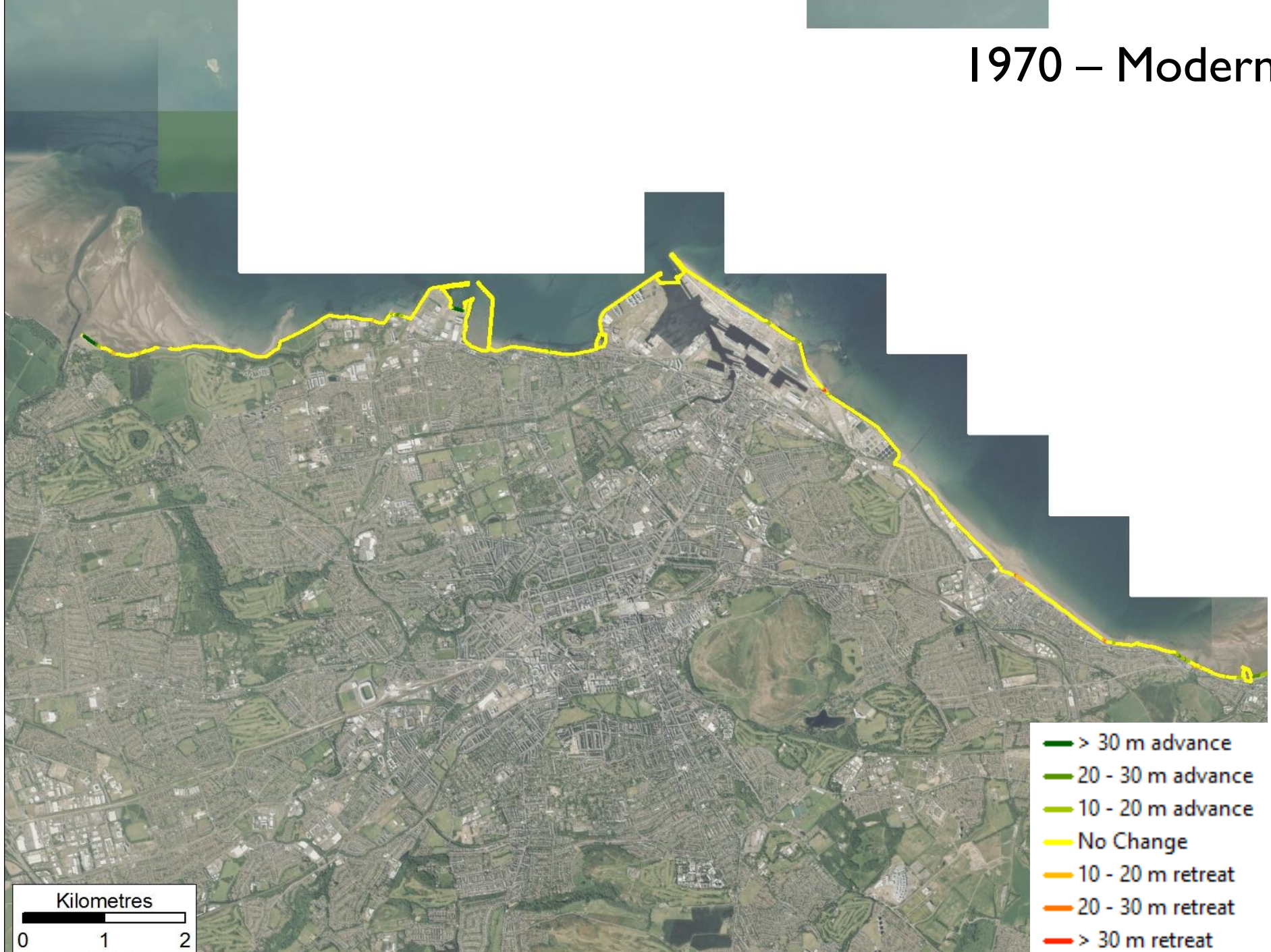
Portobello



Kilometres

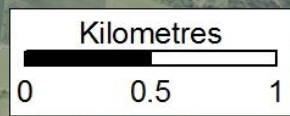
0 0.2 0.4

1970 – Modern



- > 30 m advance
- 20 - 30 m advance
- 10 - 20 m advance
- No Change
- 10 - 20 m retreat
- 20 - 30 m retreat
- > 30 m retreat

1970 – Modern



Coastal Management Legacy...



- History of land claim/coastal engineering
 - Mostly artificial/protected coastline

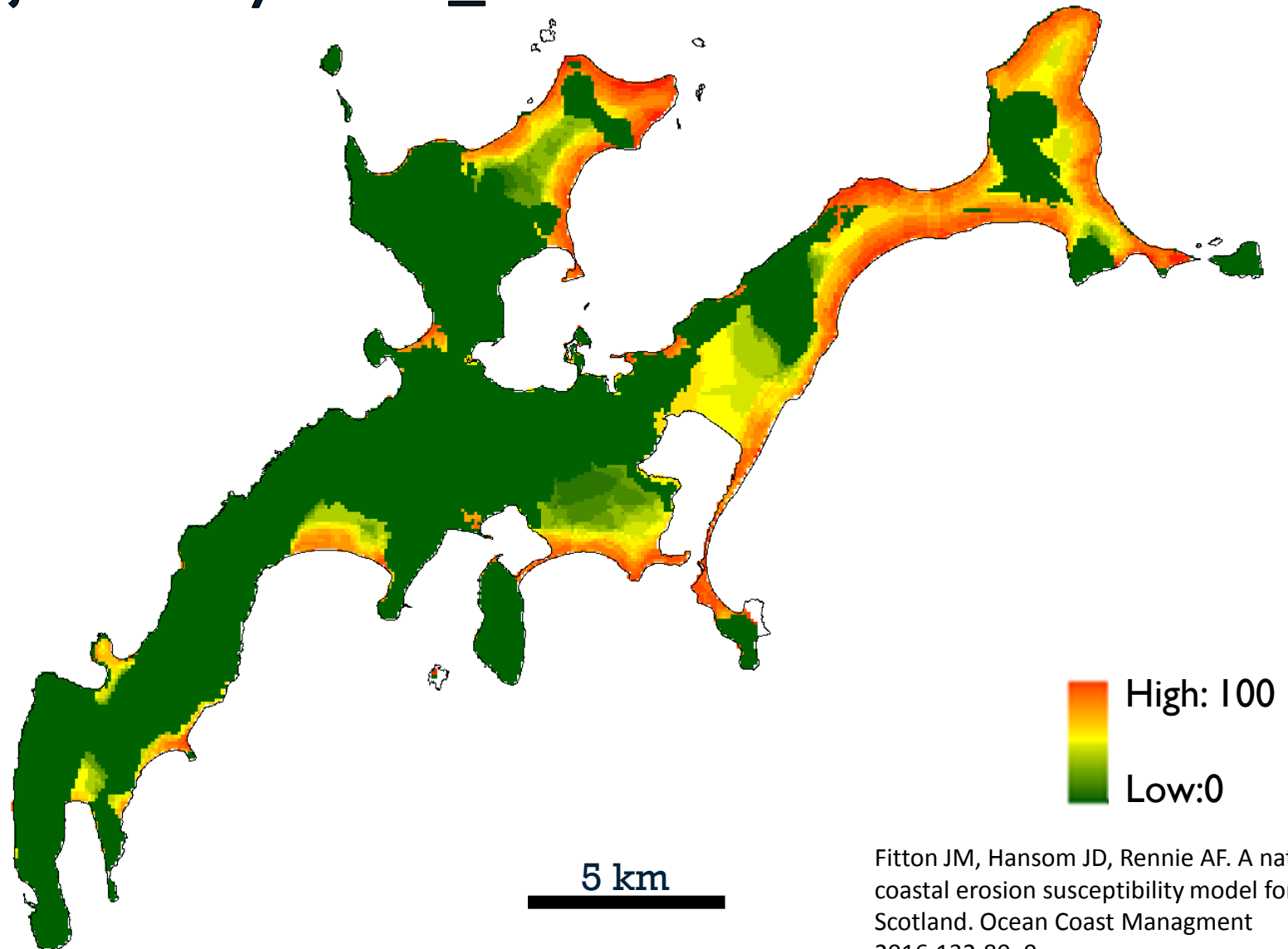


The present...

- Coastline is protected currently, but will this always be the case?
- Therefore coastal erosion/flooding problems will develop...
- We need to think about the erosion susceptibility of the land if the defences did not exist
- What indirect effect do these defences have on the rest of the coastline?

The Coastal Erosion Susceptibility Model (CESM)

http://jmfitton.xyz/cesm_scotland



Fitton JM, Hansom JD, Rennie AF. A national coastal erosion susceptibility model for Scotland. *Ocean Coast Management* 2016;132:80–9.

Physical Parameter Ranking

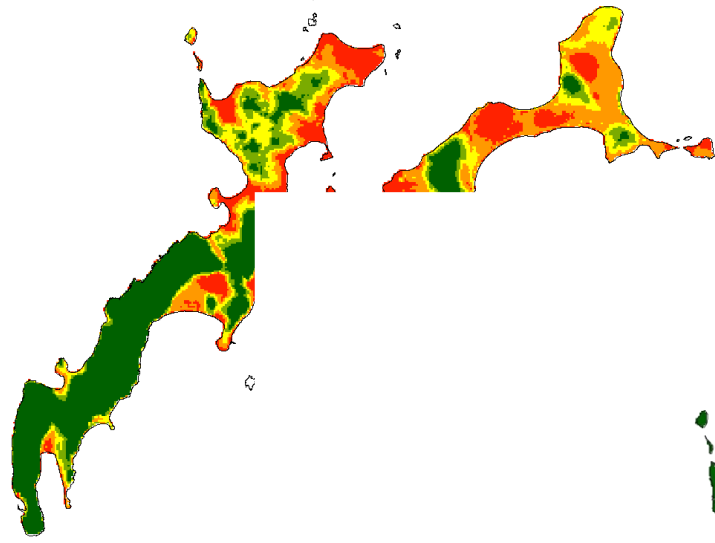
**Most
Susceptible**

**Least
Susceptible**

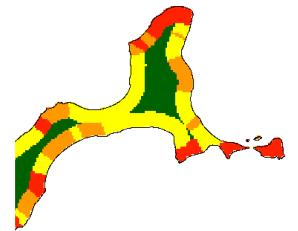
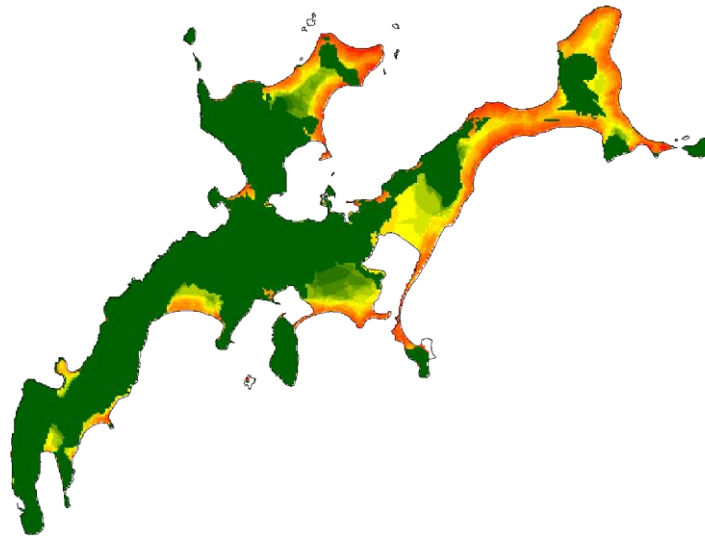
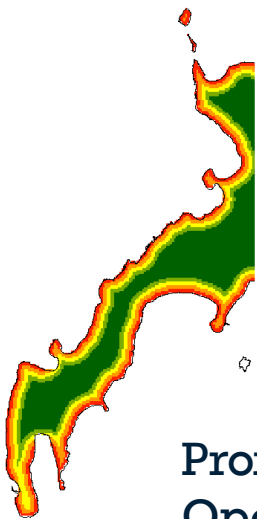
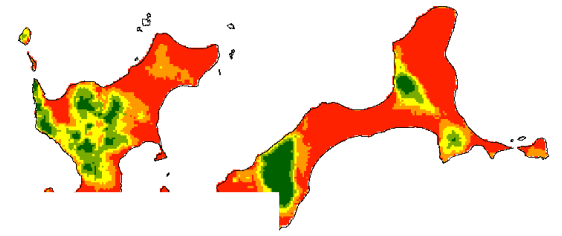
	5	4	3	2	1
Elevation (mAMHWS)	< 2	2 – 4	4 – 6	6 – 8	> 8
Rockhead (mAMHWS)	< 0	0 - 2	2 - 4	4 – 6	> 6
Proximity to Open Coast (m)	< 100	100 – 200	200 – 300	300 – 400	>400
Wave Exposure	>300	225 - 300	150 - 225	75 - 150	<75

- All in national 50 m² raster
- Wave exposure weighted 0.5

Elevation

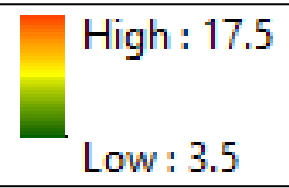
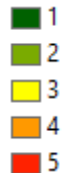


Rockhead



Proximity to Open Coast

- Max Score of 17.5
 - Min Score of 3.5
 (5 + 5 + 5 + 2.5)
 + 1 + 1 + 0.5)



Proximity to Open Coast

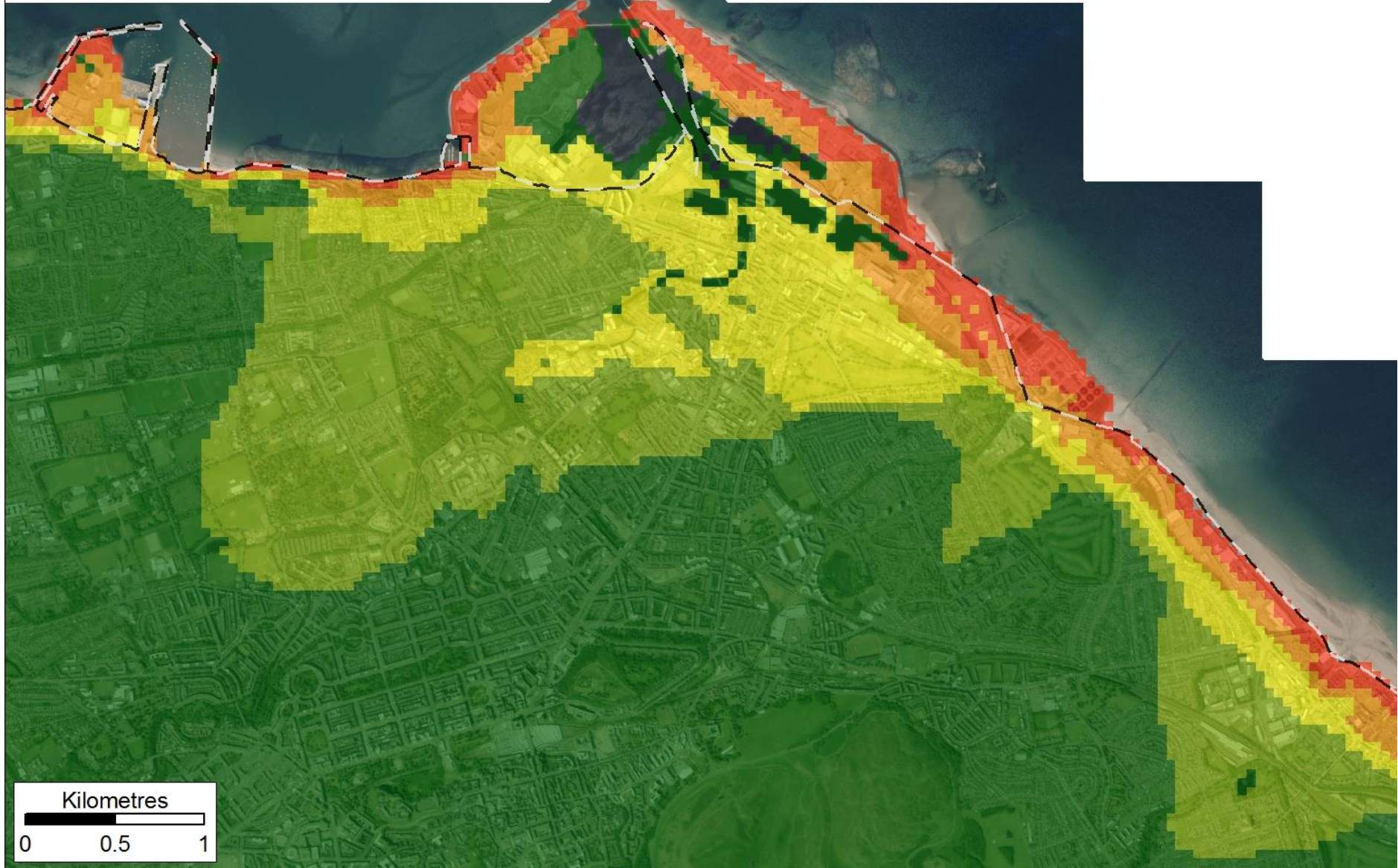


Kilometres

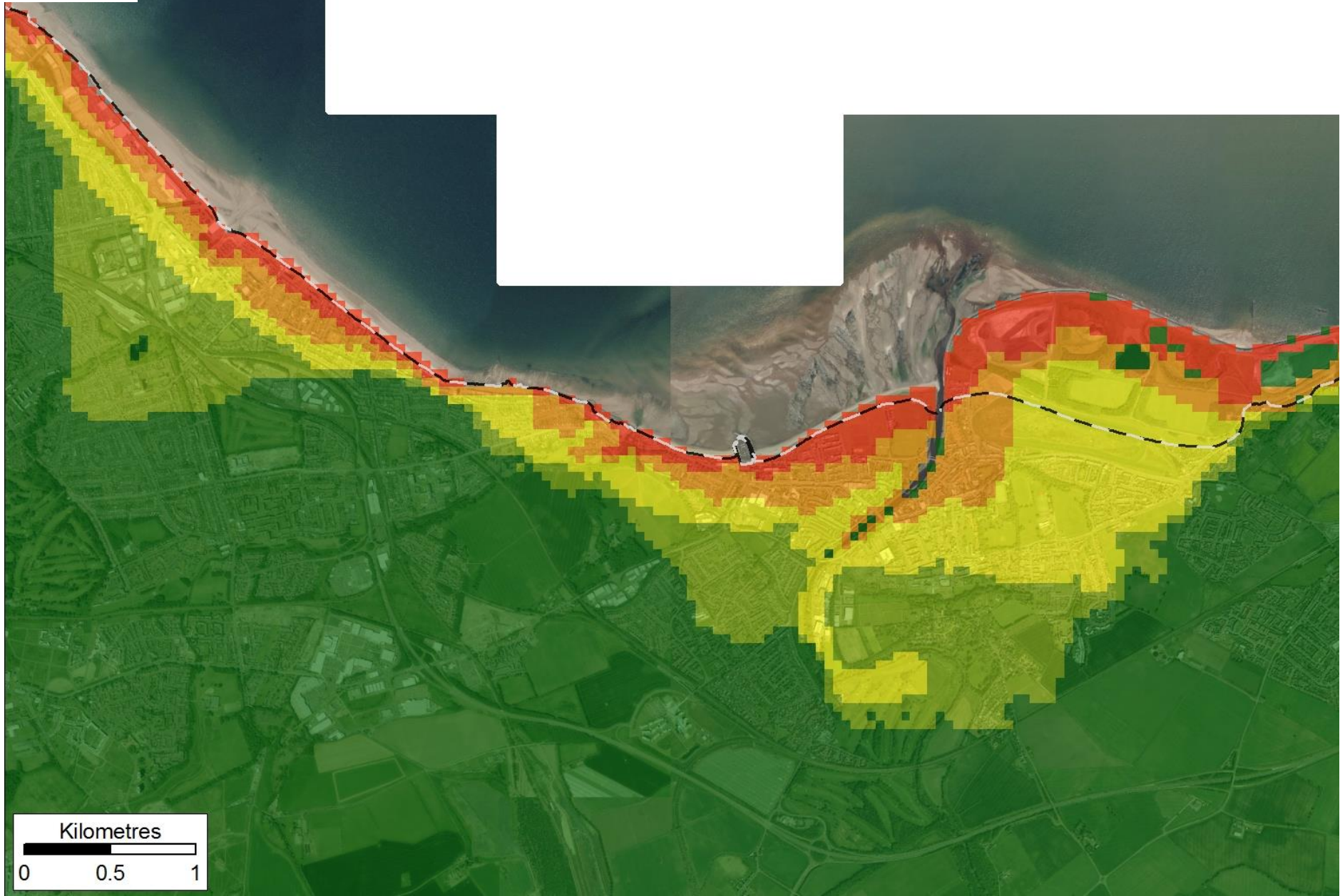
0 0.5 1



- Very Low
- Low
- Medium
- High
- Very High



- Very Low
- Low
- Medium
- High
- Very High



The effect of defences

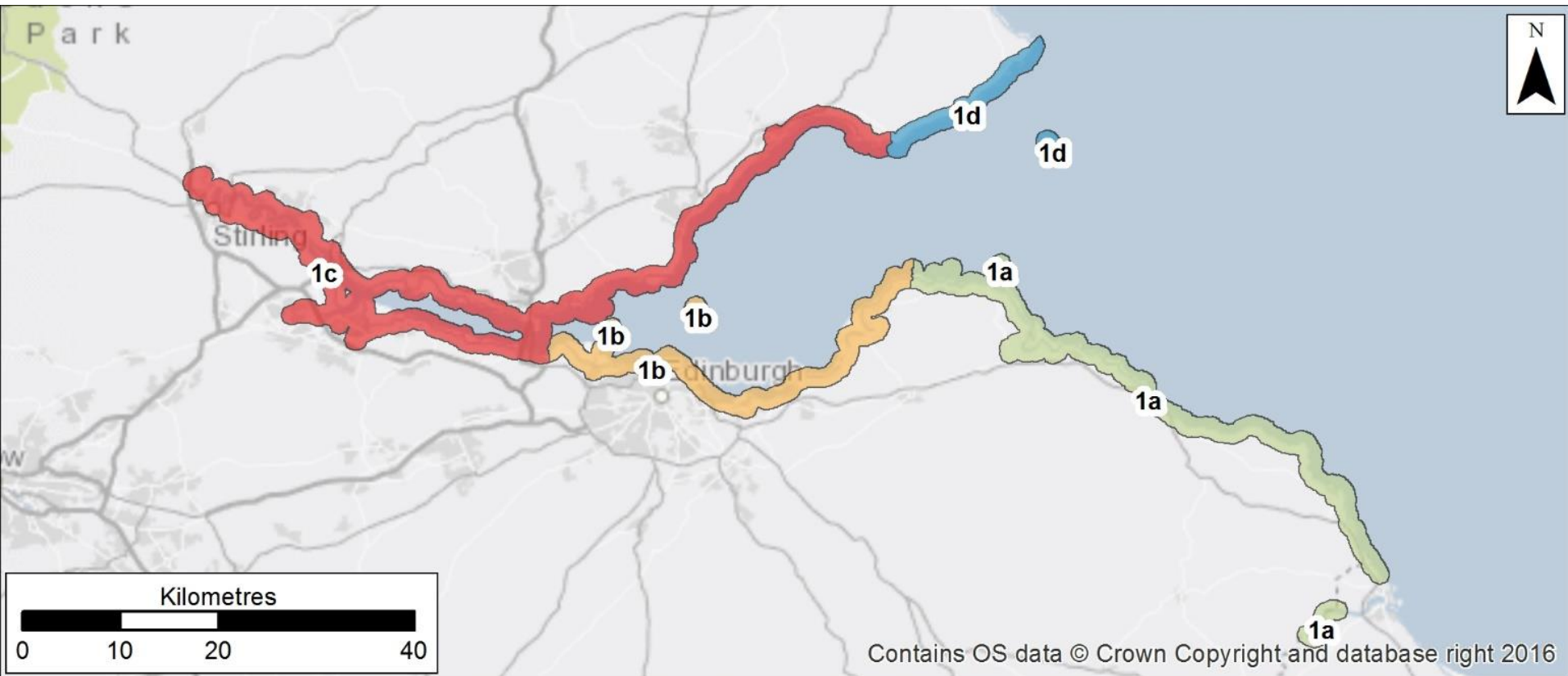
Coastal defences attempt to maintain MHWS static (or advance) has three effects:

- 1) Reduces on-site sediment supply and limits ability of the beach to respond to, and repair after, storms.
- 2) Causes beach lowering & erosional bights to form at end of defences.
- 3) Downdrift beaches are progressively starved of sediment and begin to erode.

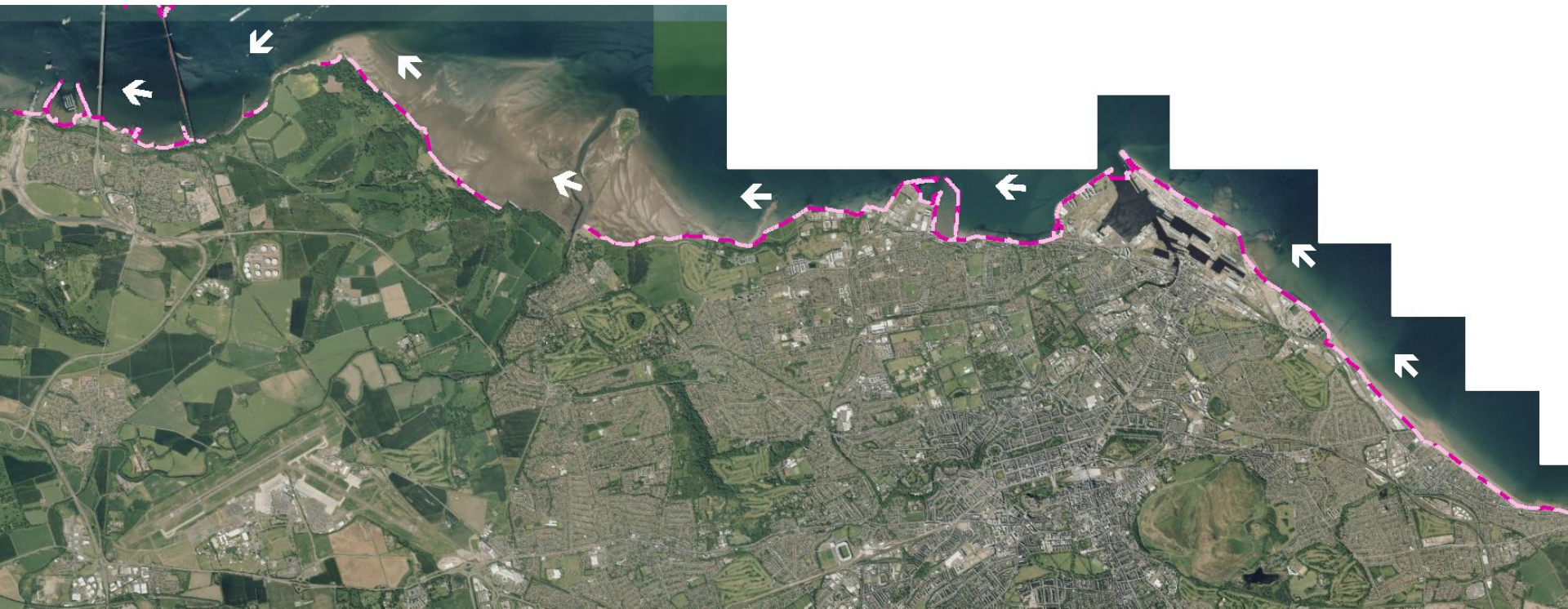


The process has now become self-perpetuating.

Coastal Cell



Coastal Cell



Cell I

- The NCCA shows that erosion rates have doubled from **0.5 m/yr** (1890-1970) to **1.0 m/yr** (1970-modern)
- In Cell I erosion rates have increased much more, from **0.2 m/yr** (1890-1970) to **1.3m/yr** (1970-modern)

The Present

- Coastal defences are protecting highly susceptible land
- This protection has allowed a whole range of socially and economically important assets to be built – i.e. development in ‘risky’ locations
- These defences indirectly impact of the rest of the coastline

The Future: Sea Level Rise

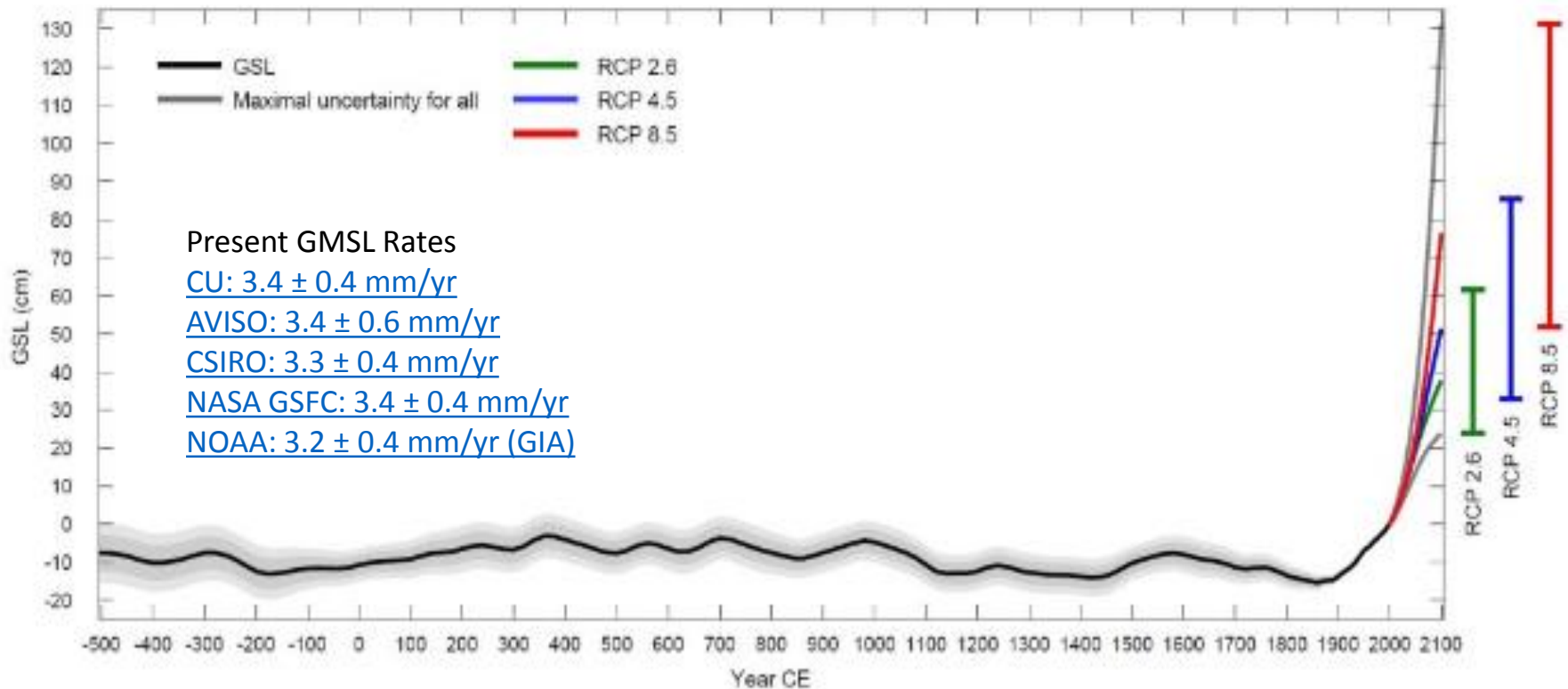
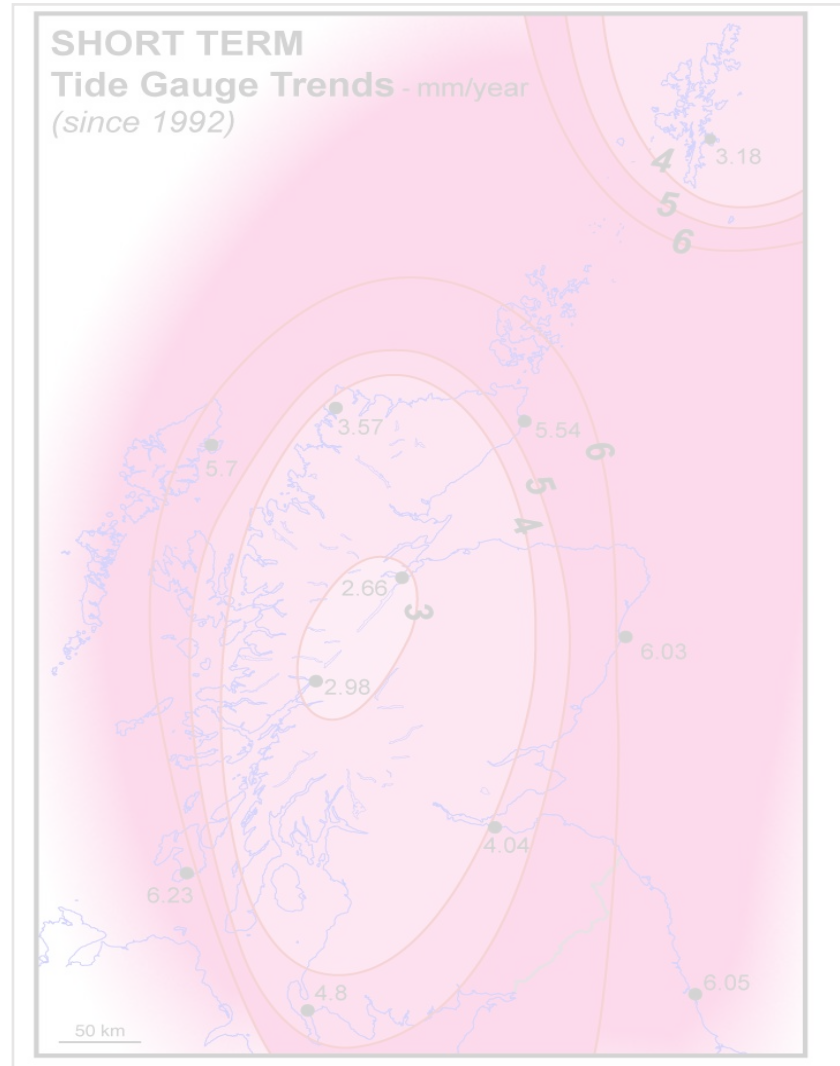
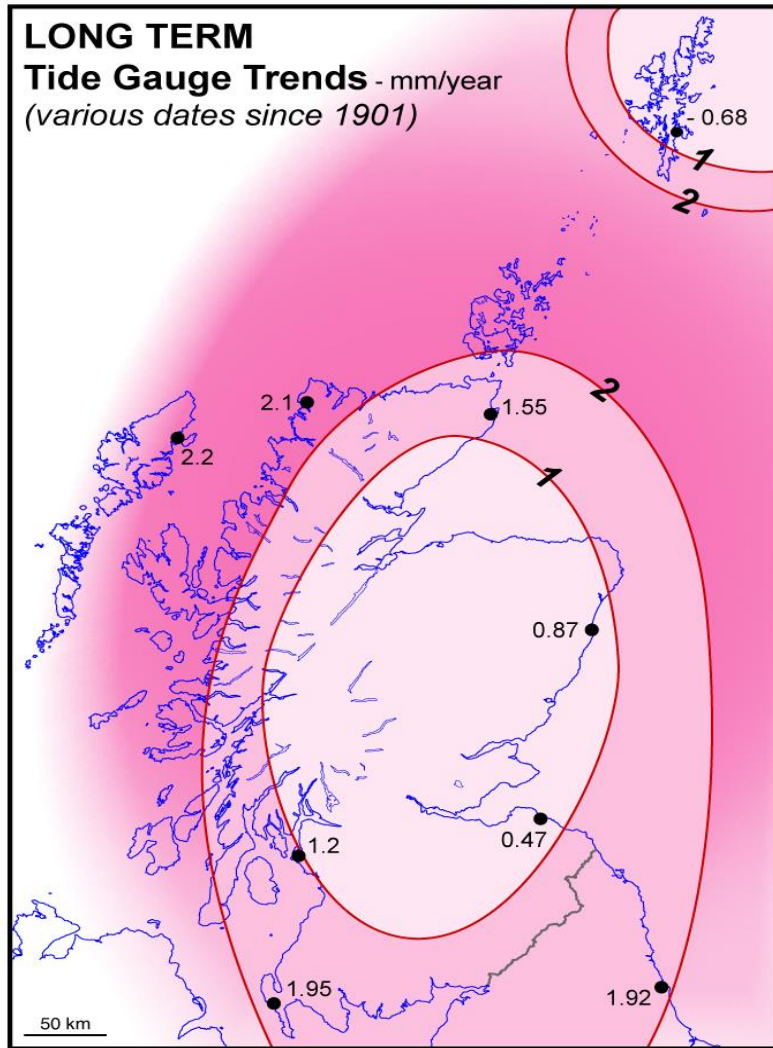


Fig. 3 The last 2500 years of sea level together with the projections of Kopp et al. for the 21st century. Future rise will dwarf natural sea-level variations of previous millennia.

The Future: Sea Level Rise



The Future: Sea Level Rise

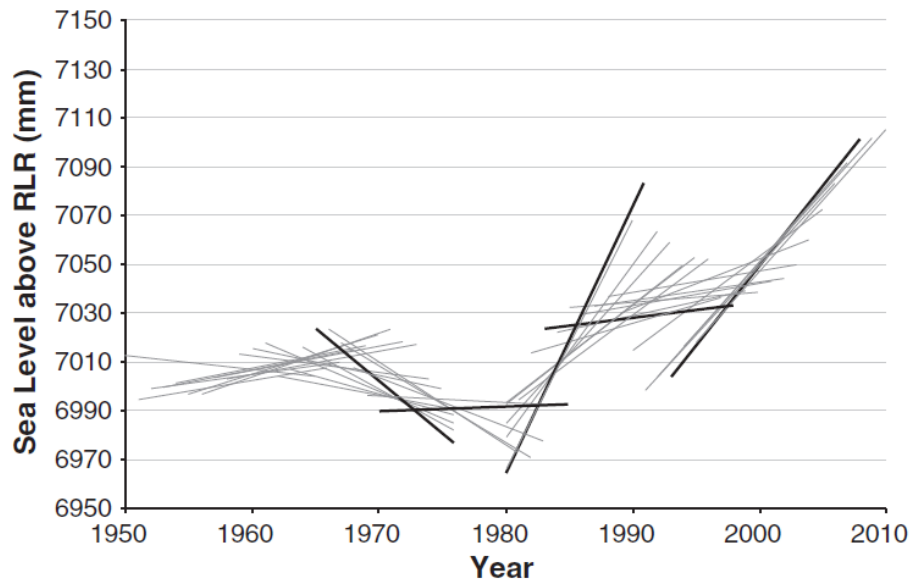
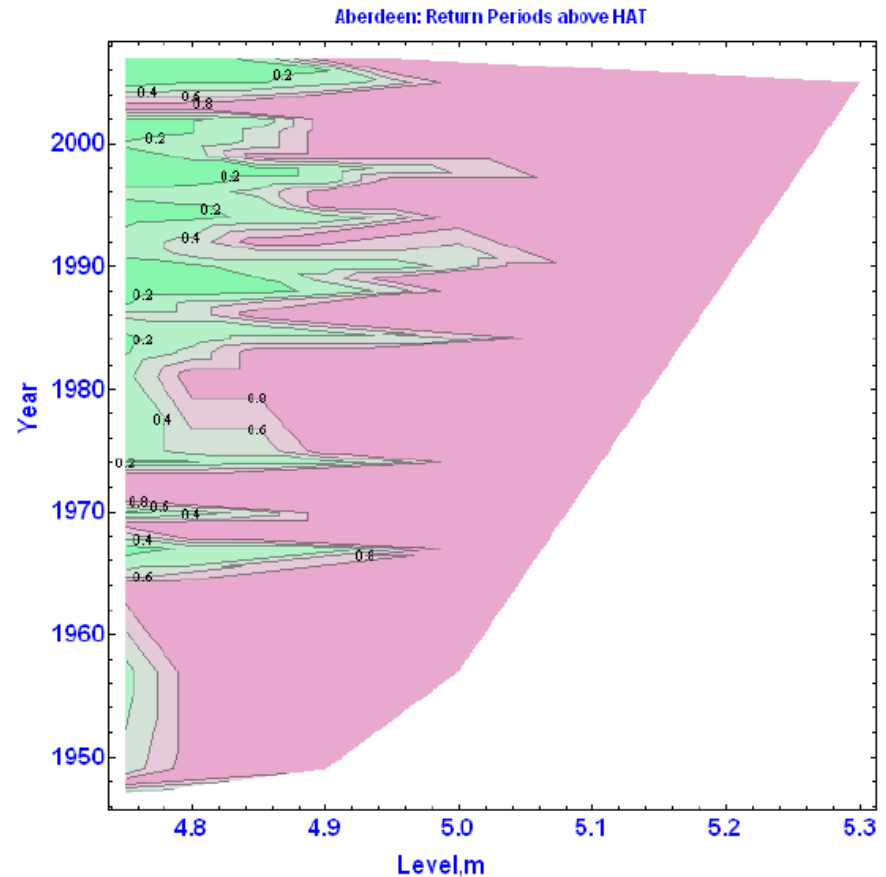


Fig. 1. Observed changes in 15 year sea level trends between 1950 and 2009 from Aberdeen RLR monthly data. All grey lines represent 15 year linear trends with the five black lines highlighting extreme variations in trend. 1966–1969 data are missing and trends beginning or ending in these years have been omitted.



(Ball *et al* 2008)

Sea Level change is noisy, but rising
across Scotland.....

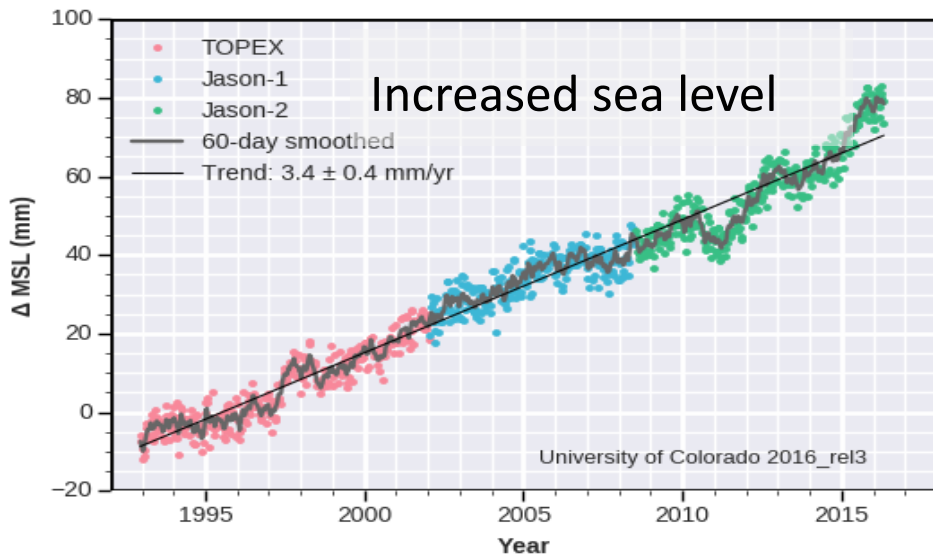
.....Leading to increases in coastal
flood frequency

The Future: Wave Heights

Wave height (Hs)	Increase rate	Season	Period	Source
NE Atlantic	2.2 cm/yr	Annual	1960-90	Bacon & Carter, 1991
NE Atlantic	2.7 cm/yr	Annual	1960-88	Bouws et al., 1996
NE Atlantic	2.5 cm/yr (min)	Annual	1955-94	Gunther et al., 1998
NW Atlantic	2.3 cm/yr	Annual	1960-88	Bouws et al., 1996
NW Atlantic	2.4 cm/yr	Annual	1976-06	Komar et al., 2010
NW Atlantic	3.2 cm/yr	Winter	1976-06	Komar et al., 2010
NW Atlantic (Hurricanes)	2.8 cm/yr	Summer	1996-05 33%inc =7.5-10m	Allen & Komar, 2009

Significant wave height increases in N. Atlantic are rising an order of magnitude faster than Mean Sea Level...2-3 cm/yr over last 4 decades....

The problems at the coast



Conclusion

- History of land claim and protection along the Edinburgh coastline
- This protects land that is inherently susceptible to erosion.
- This land (that is currently protected) is used by whole range of socially and economically important assets
- Sea level rise, increased flood frequency, increased erosion rates, reduced sediment supply will test the effectiveness and suitability of these defences

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Scotland's Dynamic Coast

Latest News About ▾ Outputs Web Maps Contact

Scotland's Coastal Change Assessment

[About the Project](#) [See the Web Maps](#)

 The Scottish Government
Riaghaltas na h-Alba

 University of Glasgow

 Scottish Natural Heritage
Alba Aonachd

 crew
Scotland's centre of expertise for waters

 SEPA
Scottish Environment Protection Agency

 Ordnance Survey

 marinescotland

 Adaptation Scotland
Adaptation Scotland

 SCAPE
Scottish Coastal Archaeology and the Problem of Erosion

 Fife Council

 HISTORIC SCOTLAND
ALBA AOSMHOR

www.dynamiccoast.com

URBAN COASTAL ADAPTATION – POLICY DIMENSION



TALK OUTLINE



1. Daniel John's Adaptive Societies
2. Avoidable lock-ins
3. Policy Appraisal
4. Embedding coastal adaptation
5. Key findings thus far

http://img.dailymail.co.uk/i/pix/2008/03_02/WaveAPEX1103_800x515.jpg

Storm at Sennen, 3 February 2008

1. Daniel Johns's blueprint for adaptive societies

1. Actions of Low/No Regret
2. Not making problems worse by making L-T decisions now that increase our risk (avoid lock-ins)
3. Prepare now for L-T risks and impacts



1. Daniel Johns's blueprint for adaptive societies

1. **Actions of Low/No Regret**

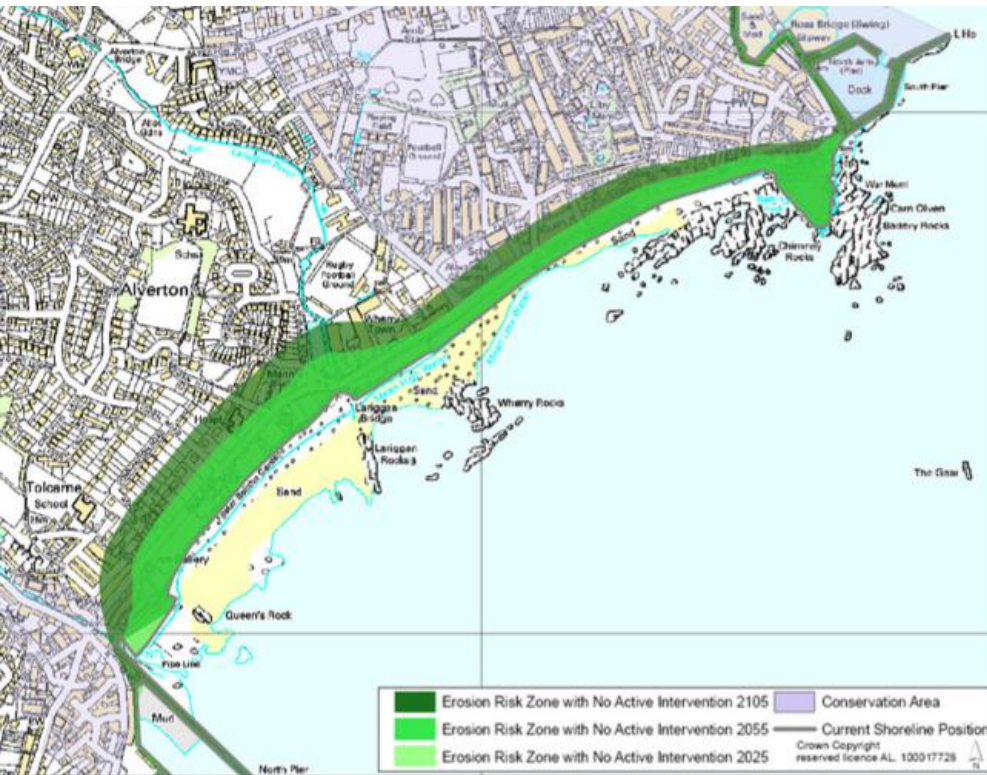
2. **Not making problems worse** by making L-T decisions now that increase our risk (avoid lock-ins)

3. **Prepare now** for L-T risks and impacts

“Development in the floodplain, along with ongoing increases in impermeable surfacing, is likely to be adding to long-term costs and risks due to weaknesses in how planning policy is being implemented.”

Scottish Climate Change Adaptation Programme: An independent assessment for the Scottish Parliament
| Committee on Climate Change, 2016.

2. Avoidable lock-ins in Penzance



2. Avoidable lock-ins in Penzance



Lidl is going to demolish its store in Penzance - and replace it with one that's double the size

2. Avoidable lock-ins in Scotland?



3. Why do we need a policy appraisal?



Mismatch between policy ‘visions’ / intent at high level and practical adaptation on the ground

“In relation to EU policy, we need to know what we are doing, what we should be doing but aren’t and where we should be talking across sectors to enable delivery”

Glasgow City Council, March 2016



3. Policy appraisal and mapping goals

1. **LADDDERS:** To identify which policies can help facilitate positive climate change adaptation
2. **SNAKES:** And those that act as barriers or constrain our adaptive capacity
3. **WINDOWS & WAGONS:** using storms as opportunities and hitching adaptation to the right 'policy wagons'



3. Policy Appraisal and Mapping

How are we doing this?

1. Adapting DEFRA evidence-based review protocols to systematically assess 'climate' and 'coastal' readiness of policies
2. Evaluate x-sectoral policy awareness of my users and to aid them in bridging policy silos to enable better adaptation aware decision-making



Policy Mapping Method

Three-stage process:

- ▣ Systematic review
- ▣ Awareness /Embedding classification
- ▣ Interpretation



Awareness Category

‘Climate focused’

‘Climate aware - high’

‘Climate aware - low’

‘Climate unaware’

Indicators

Responding to climate change the primary aim of the policy or strategy.

Document focused on particular issue whilst framing the issue in context of climate change throughout. Often exhibit detailed scientific or technical understanding of the issues.

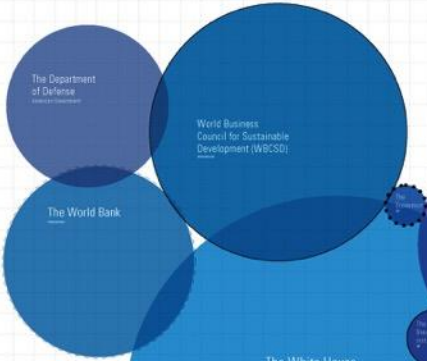
Climate change addressed in passing or issues restricted to a single section of the text.

No reference to climate change.

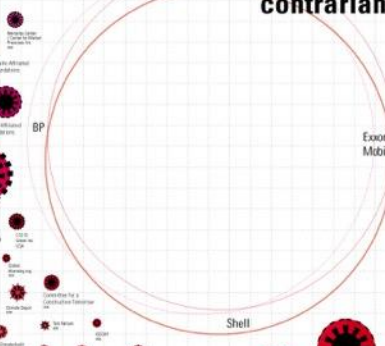
Mapping Climate Communication No2, Network of Actors: USA, UK and Canadian Based Institutions, Organizations and Individuals

Version 2.0 | October 2014

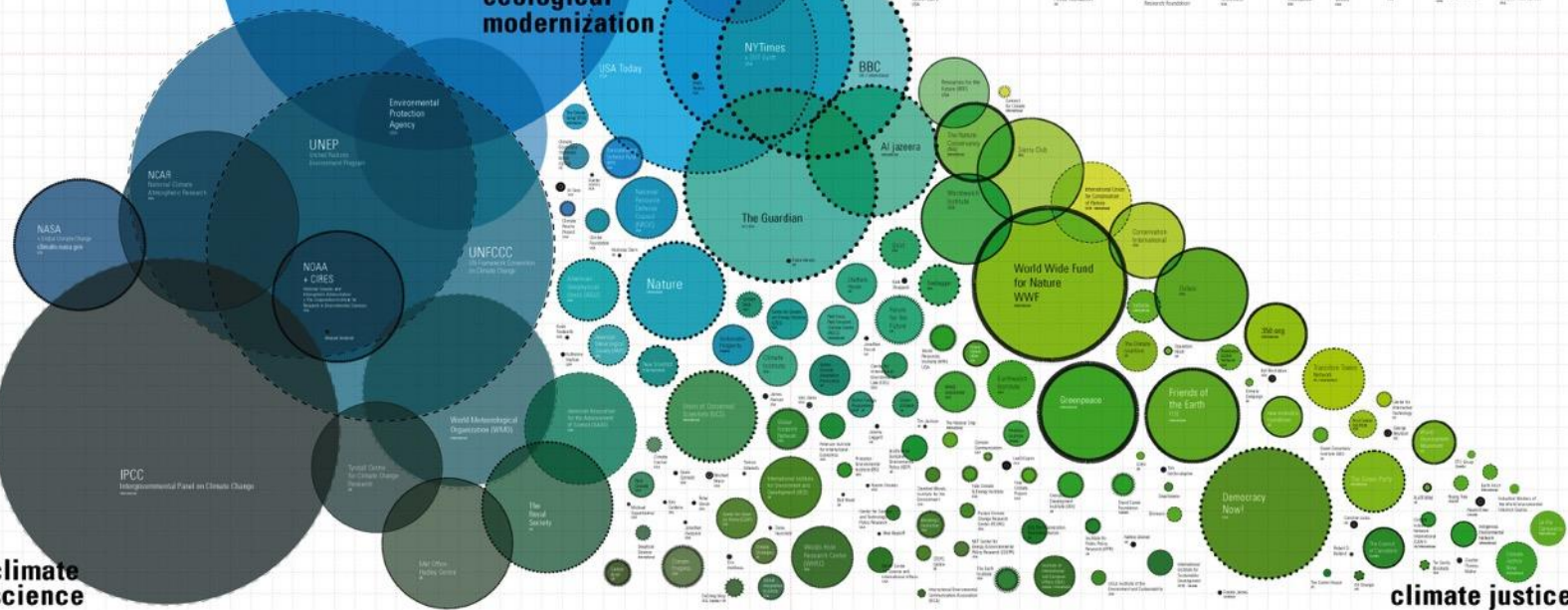
neoliberalism



climate contrarian

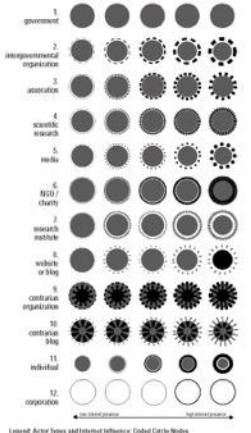


ecological modernization



climate science

climate justice



How to Read this Map

This actor network diagram depicts actors and relationships between prominent climate contrarian, neoliberal, ecological modernization, and climate justice actors across the United States, Canada and the United Kingdom. Actors are sized by actor type and their network influence.

How to Read this Map

This actor network diagram depicts actors and relationships between prominent climate contrarian, neoliberal, ecological modernization, and climate justice actors across the United States, Canada and the United Kingdom. Actors are sized by actor type and their network influence.

Actors are sized on the framework with the following metrics: (circle size) actor network influence; (circle color) actor type; (circle shading) actor network influence. The size of the circle represents the actor's influence on the climate contrarian, neoliberal, ecological modernization, and climate justice actors. The color of the circle represents the actor's type. The shading of the circle represents the actor's network influence.

The labels types of actors listed above are coded by actor type. Actor types are listed in the legend.

Labels are sized on the framework with the following metrics: (circle size) actor network influence; (circle color) actor type; (circle shading) actor network influence. The size of the circle represents the actor's influence on the climate contrarian, neoliberal, ecological modernization, and climate justice actors. The color of the circle represents the actor's type. The shading of the circle represents the actor's network influence.

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Discussions

Discussions on the role of actors in climate communication and the role of actors in climate communication and the role of actors in climate communication.

Methodology

Methodology used in this study and the way...

Center for Science and Technology Policy Research

CIRES

University of Colorado Boulder

James R. Boylston

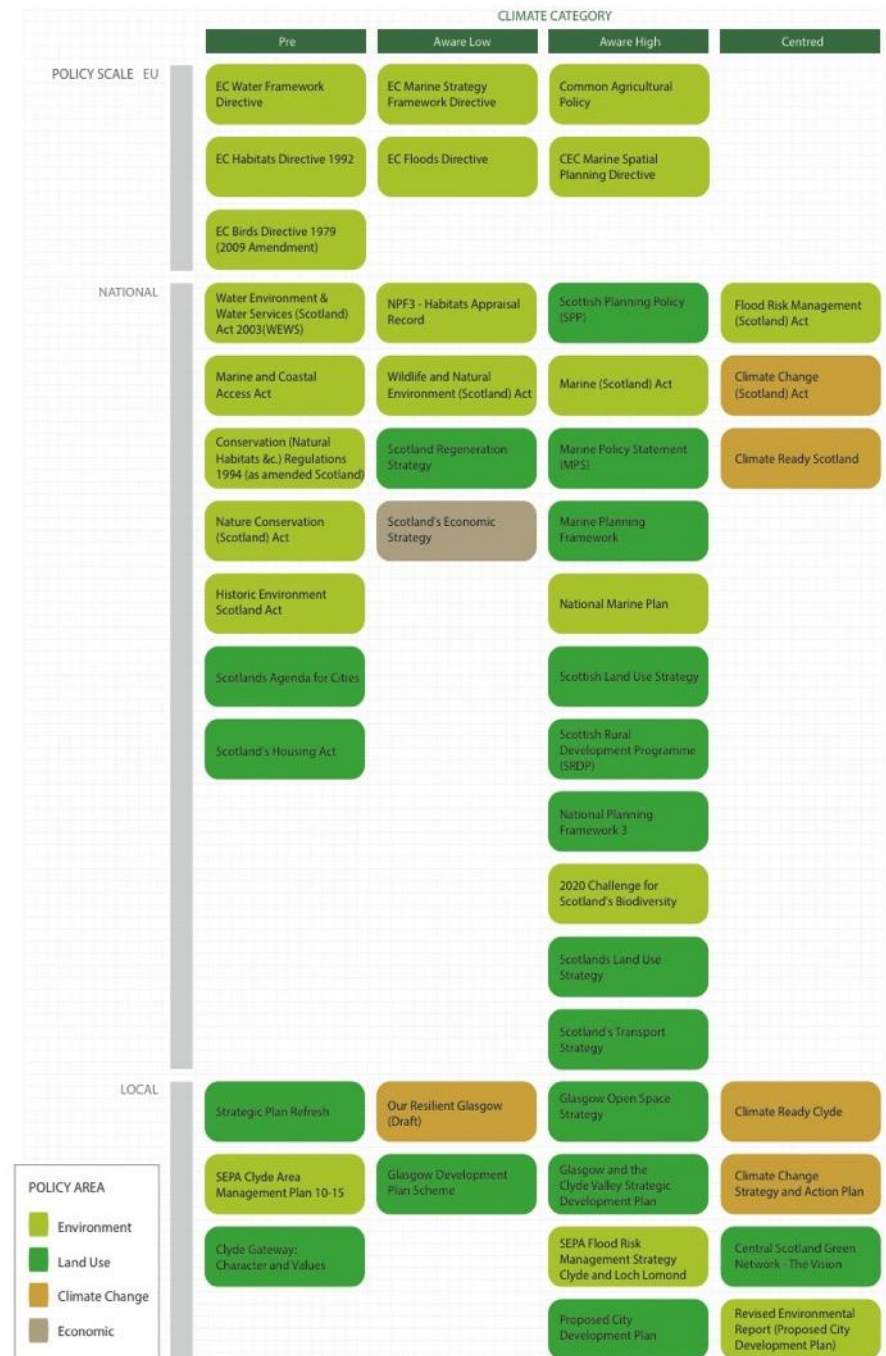
James R. Boylston

Network Mapping Climate Communication Perspective and Discourse

Actor	Type	Influence
The Department of Defense	Government	Low
World Business Council for Sustainable Development (WBCSD)	Intergovernmental Organization	High
The World Bank	Government	High
The White House	Government	High
UK Coalition Government	Government	High
Canadian Government	Government	High
The House and the Senate	Government	High
The Chamber of Commerce	Government	High
Fox News	Media	High
BP	Corporation	High
Exxon Mobil	Corporation	High
Shell	Corporation	High
The Wall Street Journal	Media	High
CNN	Media	High
The Sun	Media	High
The Guardian	Media	High
Nature	Media	High
BBC	Media	High
UNFCCC	Intergovernmental Organization	High
WWF	NGO	High
Greenpeace	NGO	High
Friends of the Earth	NGO	High
Democracy Now!	NGO	High
NOAA	Research Institute	High
ICF	Research Institute	High
IPCC	Research Institute	High

3. Climate awareness policy mapping by:

- climate awareness level (Low to High)
- policy scale (EU to local)
- policy area (e.g. Environment, Development, Economic)
- One assessment per case study area (Cornwall, Glasgow, Suffolk)



3. Initial Assessment of 'Coastal Awareness'

Policy Document	climate change	adapt	flood	coast	estuar	sea	sea level	vulnerab	resilien
Glasgow and the Clyde Valley Strategic Development Plan	X	X	X	X	X	X	X		
SEPA Flood Risk Management Strategy Clyde and Loch Lomond	X	X	X	X	X	X	X	X	X
Proposed City Development Plan	X	X	X	X	X			X	X
Climate Ready Clyde	X	X	X	X		X	X	X	X
Climate Change Strategy and Action Plan	X	X	X	X		X		X	X
Central Scotland Green Network - The Vision	X	X	X	X					2
Revised Env't'l Report (Proposed City Dev't Plan)	X	X	X	X				X	X
The River Clyde Flood Mgmt Strategy Dev't Guide	X	X	X			X	X		
River Clyde Flood Management Strategy	X	X	X			X	X		
Glasgow Open Space Strategy	X	X	X					X	X
Our Resilient Glasgow (Draft)	X	X	X					X	X
Glasgow City Plan 2 Summary	X		X						
Glasgow Development Plan Scheme	X								
Clyde Gateway: Character and Values		X							
SEPA Clyde Area Management Plan X0-X5			X	X	X	X			
Strategic Plan Refresh								X	X
Number of policies referring to each word:	13	12	13	8	6	7	5	8	9

3. Temporal mismatch

- Coastal engineering schemes are typically built for >80 years
- Land-based & economic policies typically have much shorter time horizons
- Mis-match affecting adaptive capacity

Table 2. Initial timescale analysis of local Scottish policies (blanks = no clear timescale provided)

Policy	Time Scale	Policy Type	Statutory Status
SEPA Clyde Area Management Plan X0-X5	2015	Strategy	Non-Statutory
Strategic Plan Refresh	2017	Strategy	Statutory
Climate Change Strategy and Action Plan	2017	Strategy	Non-Statutory
Our Resilient Glasgow (Draft)	2017	Vision	Non-Statutory
SEPA Flood Risk Management Strategy Clyde and Loch Lomond	2021	Plan	Non-Statutory
Glasgow Open Space Strategy	2027	Vision	Non-Statutory
Clyde Gateway: Character and Values	2028	Vision	Non-Statutory
Glasgow City Plan 2 Summary	2029	Strategy	Statutory
Glasgow and the Clyde Valley Strategic Development Plan	2035	Plan	Non-Statutory
Climate Ready Clyde	2050	Vision	Non-Statutory
Central Scotland Green Network - The Vision	2050	Vision	Non-Statutory
Proposed City Development Plan	2020	Strategy	Statutory*
Glasgow Development Plan Scheme	2020	Plan	Statutory*
Revised Environmental Report (Proposed City Development Plan)	2020	Strategy	Statutory*
The River Clyde Flood Management Strategy Development Guide	2016	Strategy	Non-Statutory
River Clyde Flood Management Strategy	2016	Strategy	Non-Statutory

*Development Plan is a statutory requirement of the Scottish planning act - documents here part of consultation for this.

3. Policy Mapping Use (thus far)

- EA teams in Cornwall to use as an evidence base for land-based visions/placemaking
- Climate Ready Clyde Partnership in Scotland will use the data to aid policy issues emerging from Brexit
- Glasgow city council will use it to identify topics most in need of awareness raising around estuarine adaptation.

Key findings thus far

Climate Change Awareness

Is variable: needs to improve climate change awareness of legislation

Coastal Awareness

Is patchy: where coastal adaptation on land is likely, policies need to adjust to consider this.

Ecosystem-services

Is often overlooked: We need to identify opportunities for co-benefits as we develop adaptive societies

Placemaking

Is needed: to address temporal mismatch between growth/development plans & coastal engineering design life

Coastal adaptation in the Forth

- **Aim:** to assess the extent to which climate risks are being addressed in coastal planning and management
- **Policy appraisal** (key word search of planning documents)
- **Interviews** (flood prevention officers, planning officers, development officers)

Policy opportunities in Edinburgh?

Policy	Climate adaptation an objective or outcome?	Considers flooding/erosion?	Reference to coast?
SESplan	X	X	
Proposed SESplan		X	
SESPlan SFRA	X	X	X
SEStran Regional Transport Strategy			X
Forth Estuary LFRM Strategy	X	X	X
Forth Estuary LFRM Plan	X	X	X
Forth Area Management Plan	X	X	X
The Forth Integrated Management Strategy	X	X	X

Policy opportunities in Edinburgh?

Policy	Climate adaptation an objective or outcome?	Considers flooding/erosion?	Reference to coast?
Council Business Plan	X	X	
Edinburgh Partnership Community Plan	X		
Edinburgh Local Development Plan	X	X	X
Leith Docks Development Framework		X	X
City Housing Strategy			
Local Transport Strategy			
Local Biodiversity Action Plan	X	X	X
Open Space 2021	X	X	
Sustainable Edinburgh 2020	X		X
Resilient Edinburgh	X	X	X
Edinburgh Adapts	X	X	X

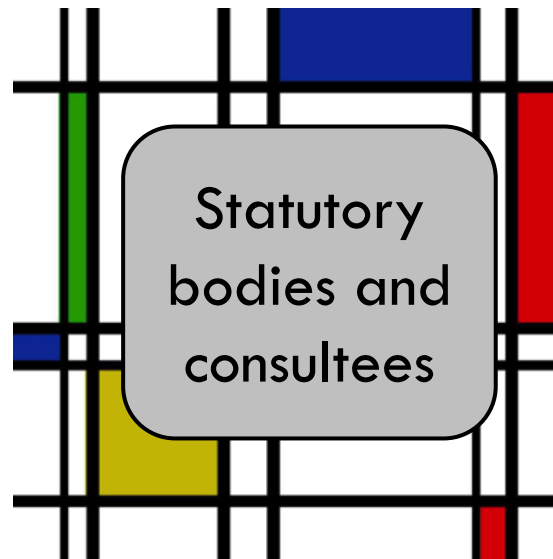
Key challenges

- Perception that coastal flooding/erosion not a significant issue
- Increasing pressure for coastal space in the Forth
- Lack of strategic approach to coastal defence
- Private ownership of the coast with different priorities
- No framework or guidance specifically to address erosion / promote managed realignment
- Limited local funds
- Limited understanding of coastal processes

4. Embedding Coastal Adaptation

As part of:

- Routine activities
- Event-recovery
- Strategic/Long-term



4. Routine Activities

- Ensure that Daniel Johns's criteria are met as part of day-to-day decisions
- Identify opportunities to embed adaptive societies into everyday practice.
- Draw on support from organisations like Adaptation Scotland
- Build partnerships with key organisations that can help you deliver adaptation

'Colonies' housing plan beside Ocean Terminal in Leith takes shape



An artist's impression of the new development. Picture: contributed

By

ALISTAIR GRANT

Published: 13:42

Updated: 13:48

Tuesday 26 July 2016



An artist's impression of the new development. Picture: contributed

By ALISTAIR GRANT

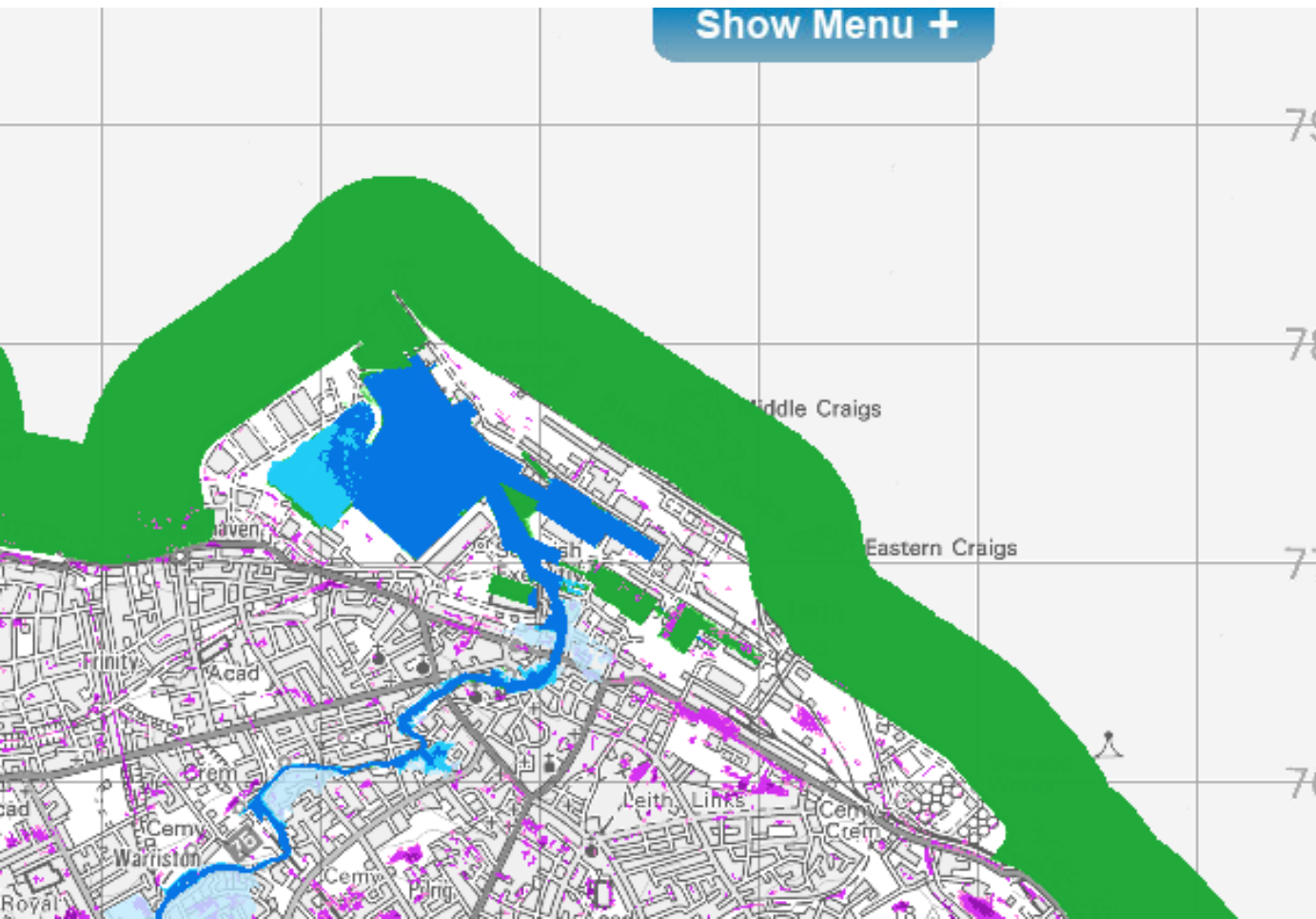
Published: 13:42

Updated: 13:48

Tuesday 26 July 2016

4. Routine Activities

Show Menu +



Map Contents

Areas that may flood - All Likelihood

River

High

Medium

Low

Surface Water

High

Medium

Low

Coastal

High

Medium

Low

Potentially Vulnerable Areas

Local Plan Districts

Local Authority

4. Storm events as adaptation windows

Winter Storms 2013/14 – Penzance



1st order
risk: Storm
and flood
risk

2nd Order:

E.g. Reputational risk in
dealing with the public,
organisational risk
associated with funding
cuts

Impact on framing of
risk and adaptation:

Strengthened
financial frame

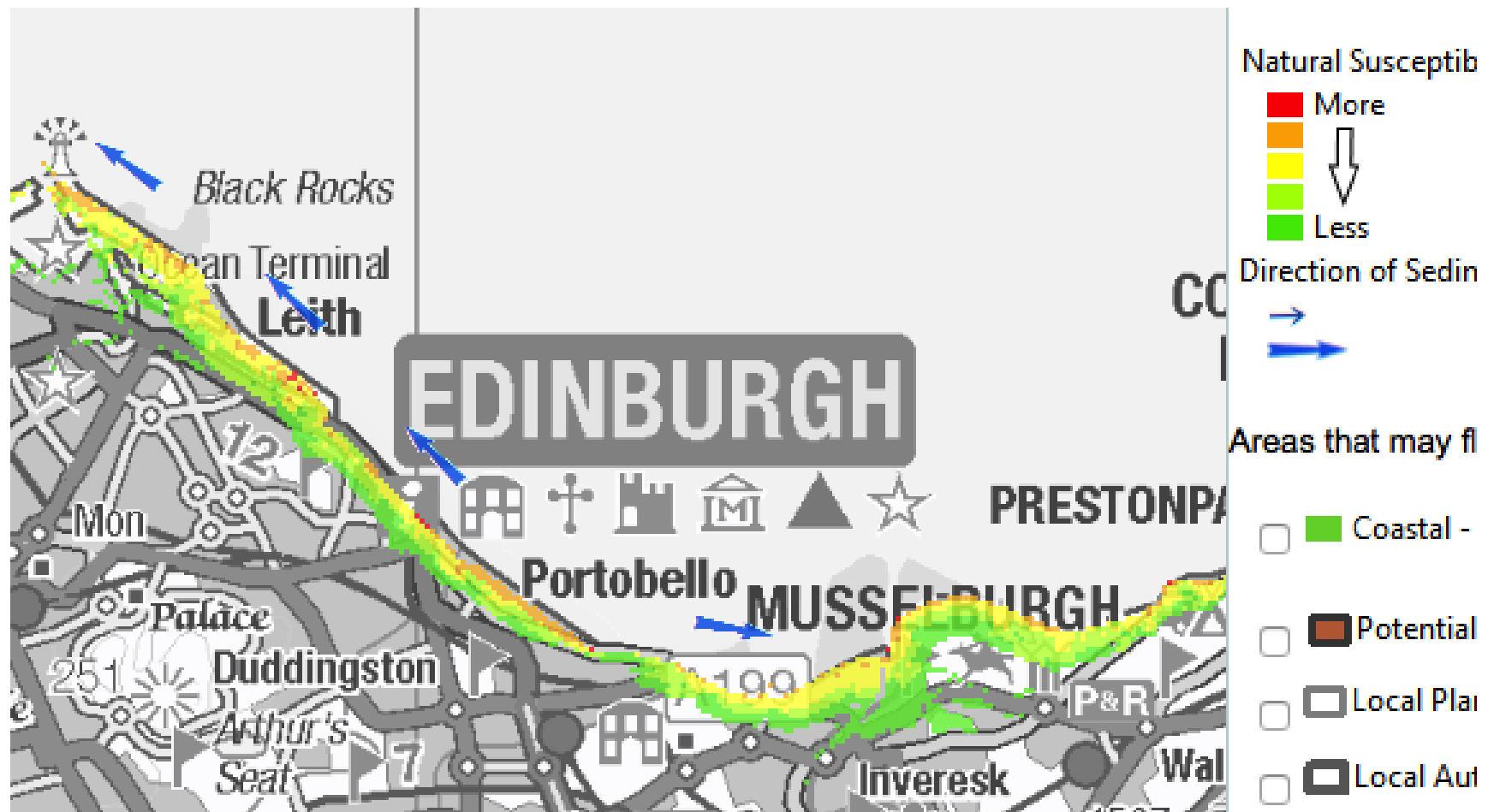
Strengthened
command and control
frame

Weakening of long
term holistic planning

4. Reframing storms as adaptation catalysts

- If we have strategic adaptation plans in place, can we implement these when the next event strikes?
- Can recovery funding be used to thus pay for adaptation rather than paying to rebuild?
- Central government responses to the 2013-14 floods did the opposite to this – can we take steps to enable Scotland to use future events as catalysts to adapt?

4. Reframing storms as adaptation catalysts





A199

The Edinburgh
Dog & Cat Home

Screwfix

Seafield Rd E

Peter Vardy Vauxhall

A199

Seafield Rd E

Graham Plumbers
Merchant

Seafield Way

A199

Nantwich Dr

Wakefield Ave

Craigentiny Rd

Kekewich Ave

Sydney Terrace

Vandeleur Ave

Byce Ave

Wakefield Ave

Seafield Rd E

Peter Vardy -
BMW Edinburgh

Vandeleur Pl

Kekewich Ave

Goff Ave

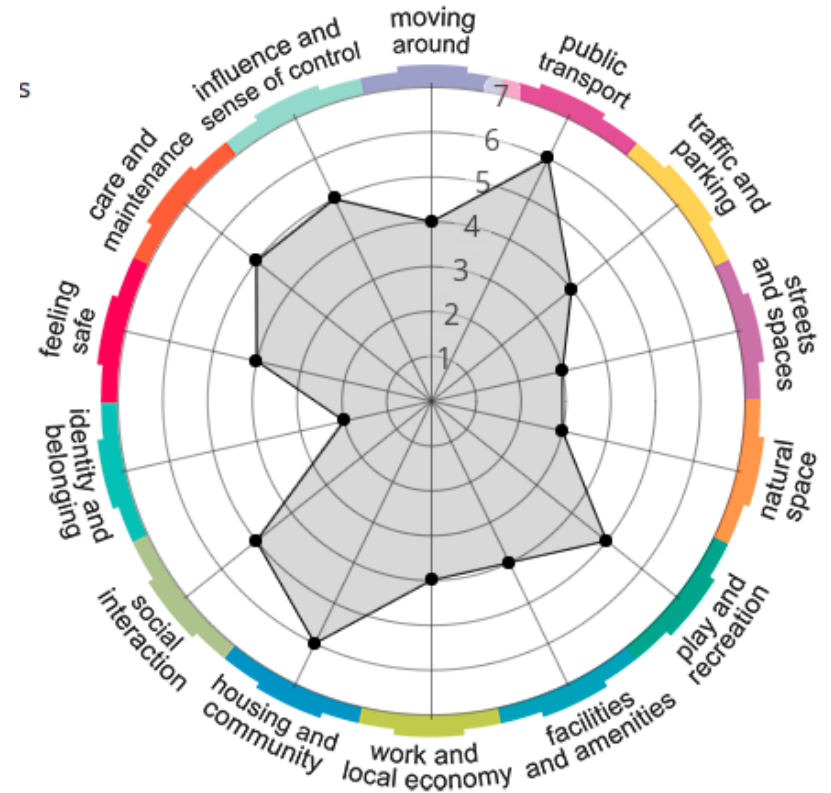
Google



4. Strategic planning – land-based visions

Placemaking

Can we vision what we want our land areas near the coast to look like, on the same time scales as engineering decisions?



Place Standard
How Good Is Our Place?

The Place Standard is a way of assessing places. Whether the place is well-established, undergoing change, or is still being planned, the tool can help you.

4. Strategic planning: using land-based policies to make space for coastal adaptation

**Green
Infrastructure?**

GI as the policy wagon? Extend to the coast?
NPPF Net Gain: use to create adaption space on land?



Greening urbanised coasts



To improve ecosystem services



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With thanks to the NERC KE Pilot Project team

TALK OUTLINE

1. What do we mean by ecosystem-based approaches?
2. Why are they needed?
3. How can we green grey in urban coastal areas?
 - Policy Drivers
 - Practical Methods



Urban Coastal Pressures

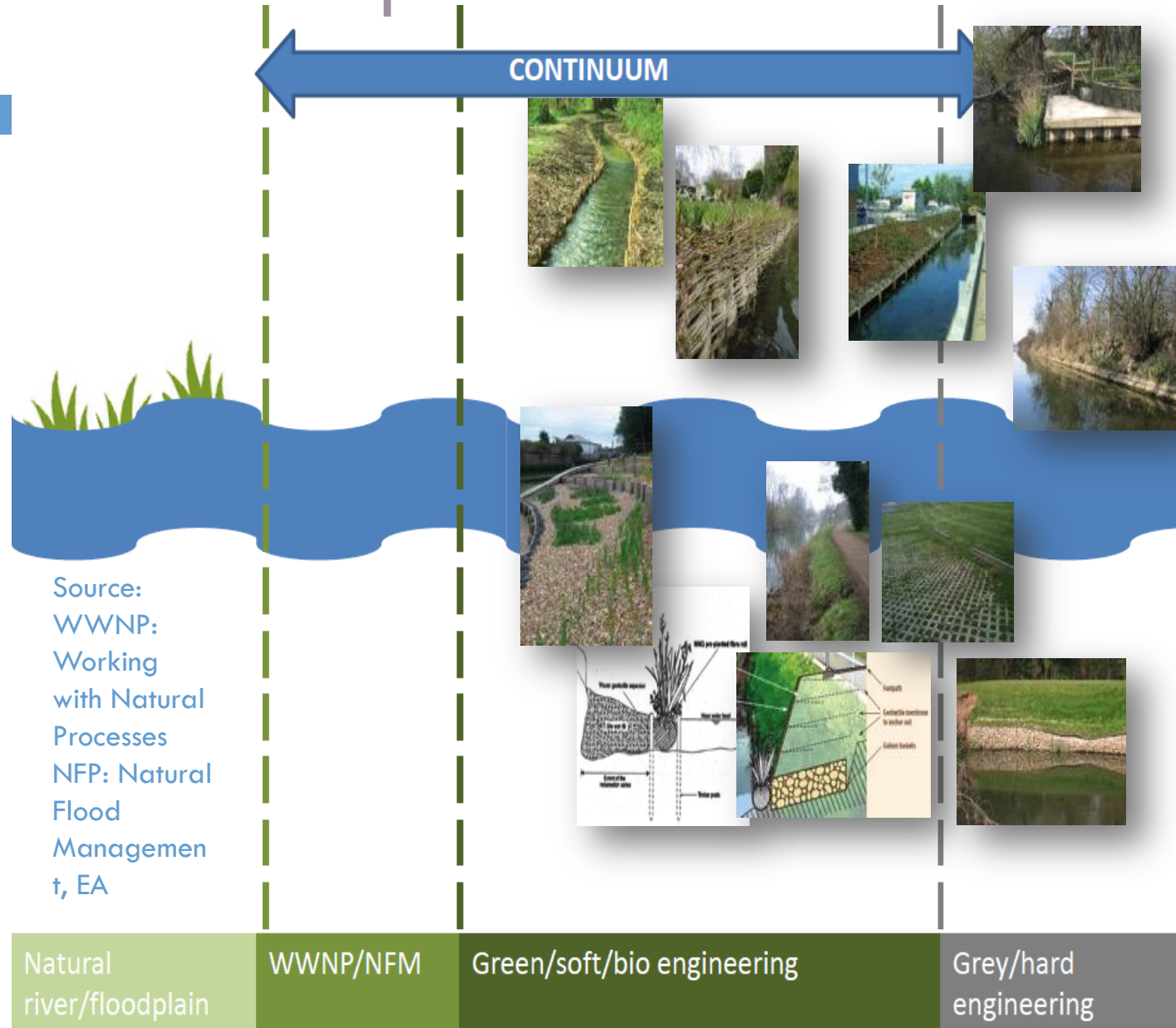


- Increasing urban coastal populations
- Increased erosion & flood risk associated with a changing climate

=

growing need for hard coastal infrastructure where softer, 'green engineering' solutions are not feasible.

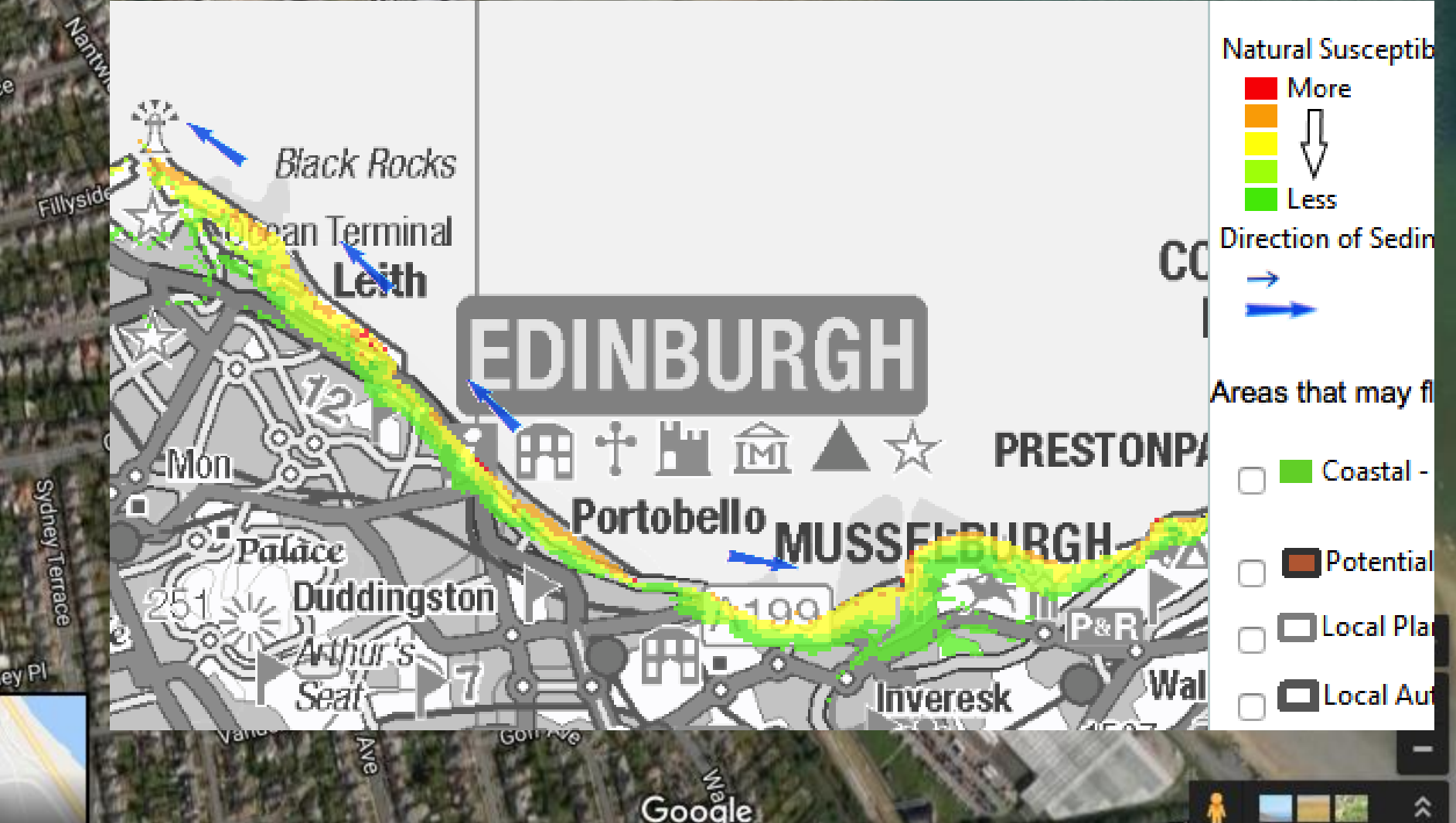
Working with natural processes



Working with Natural Processes

Natural	GI	IGGI	IGGI	Grey/Hard
Natural System (eg saltmarsh)	Semi-natural system (e.g. managed realignment)	Green Engineering /Eco Engineering (e.g. structurally engineered designs)	Ecological Enhancement: (e.g. hard defence enhancement or bioprotection)	Grey/Hard engineering (traditional, no enhancement)

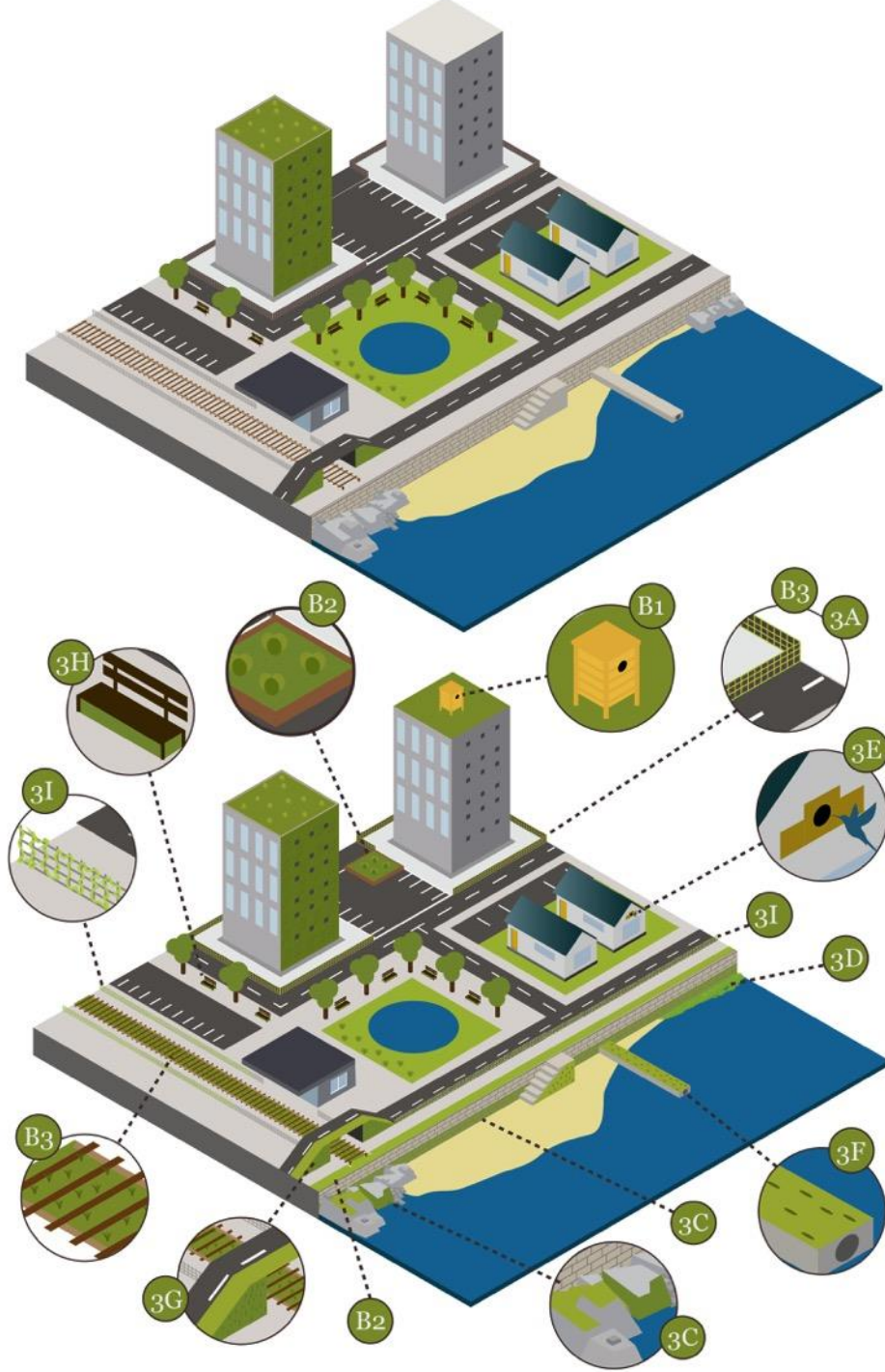




WHAT IS INTEGRATED GREEN GREY INFRASTRUCTURE (IGGI)?

“seeks to improve the multifunctionality of hard, non-building grey infrastructure assets in towns and cities by greening the parts of our cities that must remain grey”

Naylor et al. 2014



Why is it important? GI for grey assets

- Many traditional GI Approaches are not suitable for infrastructure that must remain primarily grey.
- These areas of cities provide fewer ecosystem services & have substantive climate change risks
- IGGI identifies ways of greening this infrastructure.
- It is not part of the current 'GI' policy lens



1. Naylor, LA et al. 2014. Enhancing the multifunctionality of hard infrastructure. CIRIA Briefing Note.

http://www.ciria.org/Events/Enhancing_hard_infrastructure_for_improved_multifunctionality.aspx

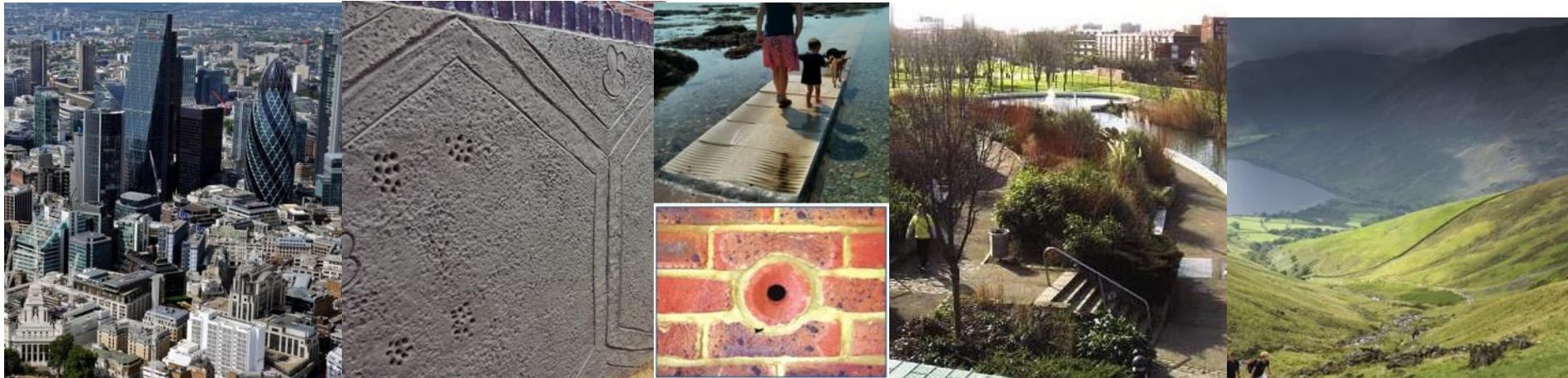
2. Source of images: @danimetcalfe and Aaron Dunkerton

A. Grey infrastructure
(e.g. flood defences, roads, walls)

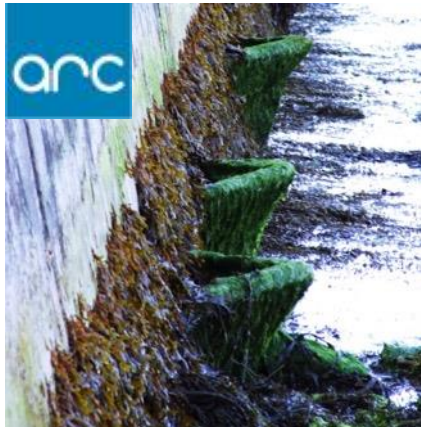
B. Integrated green grey infrastructure
(e.g. green roofs, walls)

C. Green/Blue-Green infrastructure
(e.g. wetlands, green spaces)

Continuum



Why do it? Enhancing for ecological goals



- Enhance to improve biodiversity (most common)
- To target specific species of concern
- To comply with legislation
- How:
 - Active enhancement making textures or adding vegetation to attract species
 - Passive Enhancement Material choice

Why do it? to help reduce coastal squeeze & improve amenity



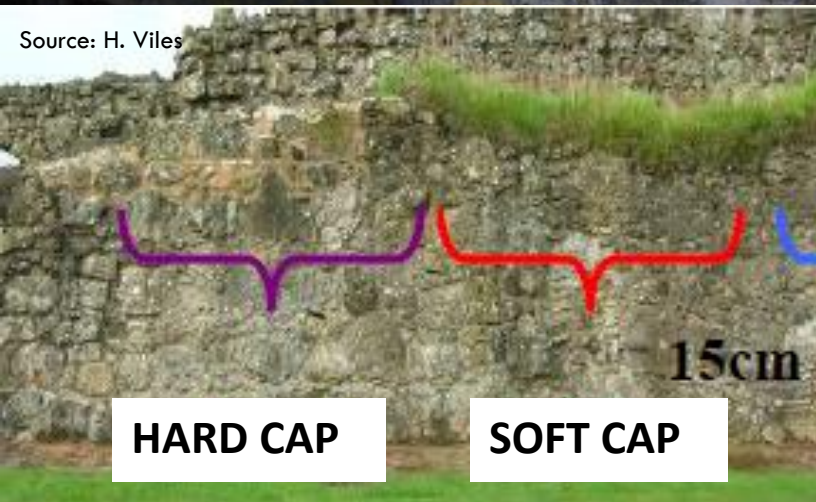
Why do it? Enhancing for asset resilience



- **Deterioration:** is one of the leading causes of decay of coastal structures and historic ruins; maintenance is expensive.

- **Tools to improve durability:** conventional methods are expensive or fail rapidly

- **Policy Push:** Improve asset sustainability & resilience



Why enhance? Policy & Legislation

Numerous instruments exist including:

- EC directives: Water Framework, Habitats, Marine Strategy, EIA, SEA
- UK laws: NERC, Marine and Coastal Planning Act, UKBAP
- For UK legislative summary see:

Including Ecological Enhancements in the Planning, Design and Construction of Hard Coastal Structures: A process guide



1. Naylor, LA et al. 2012. Facilitating Ecological Enhancement of Coastal Infrastructure: The Role of Policy, People and Planning. *Environmental Science and Policy*, 22, 36-46.
2. Naylor, LA et al. 2011. EA Guidance on Ecological Enhancement via:
http://www.therrc.co.uk/MOT/ReferencesEA_Ecological_Enhancements_Planning_Design_Construction_Hard_Coastal_Structures.pdf

Why enhance? **Non-Legislative Drivers**

What other factors have led to enhancements being included in operational schemes or research trials?

- **Corporate Social Responsibility**
- **Public Support & Financial Leverage**
- **Improved Asset Resilience**
- **Strategic Corporate Objectives**
- **Design Criteria**
- **Extreme Events**



HOW DO WE GREEN THE GREY?

ECOLOGICAL ENHANCEMENT:

“Using nature to improve the sustainability, resilience and multifunctionality of hard urban infrastructure” after Naylor et al. 2012

Ways of enhancing to create IGGI

- **Temporary** features to improve ecosystem service provision during construction
- **Retrofitting** features onto pre-existing grey assets
- **Designing in** as part of new schemes
- **Strategic** as part of strategic planning



Designing from NATURE



Source: Mairi MacArthur, PHD Candidate, University of Glasgow

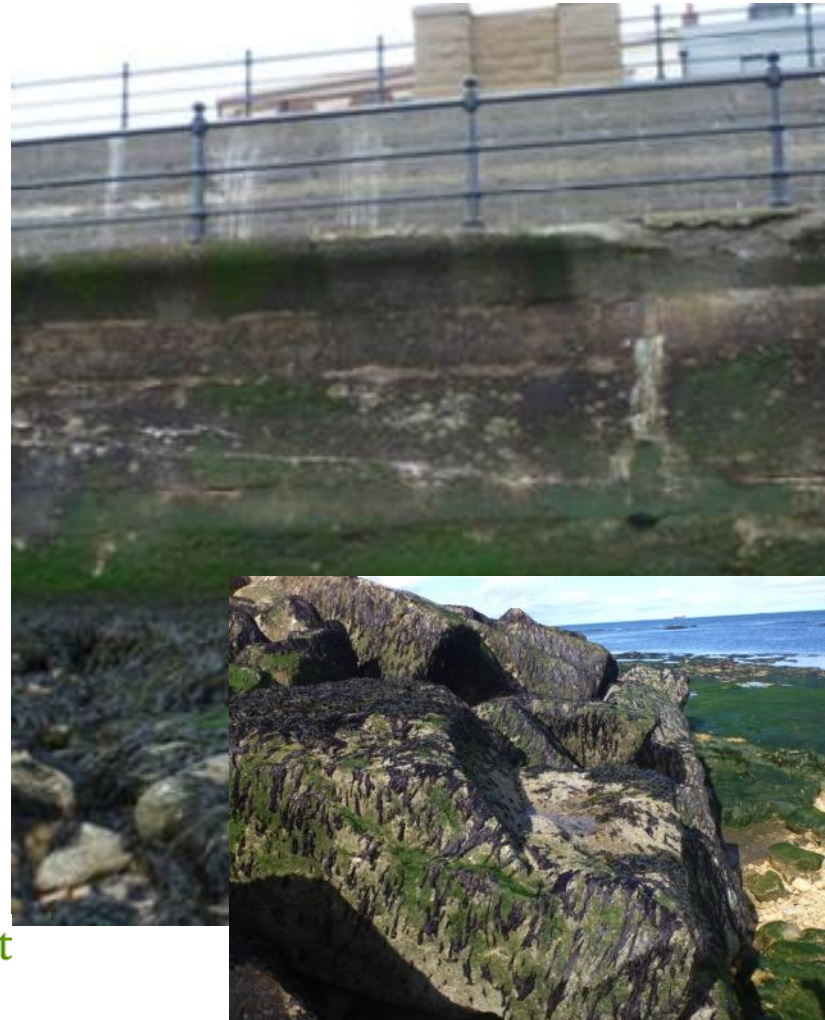
Vertipools

- Two sites Bouldner, Bournemouth and Boscombe, Great Yarmouth
- Rock pools onto existing seawalls
- Engaged public, and schools in design
- Habitat for fish, crabs, and isopods

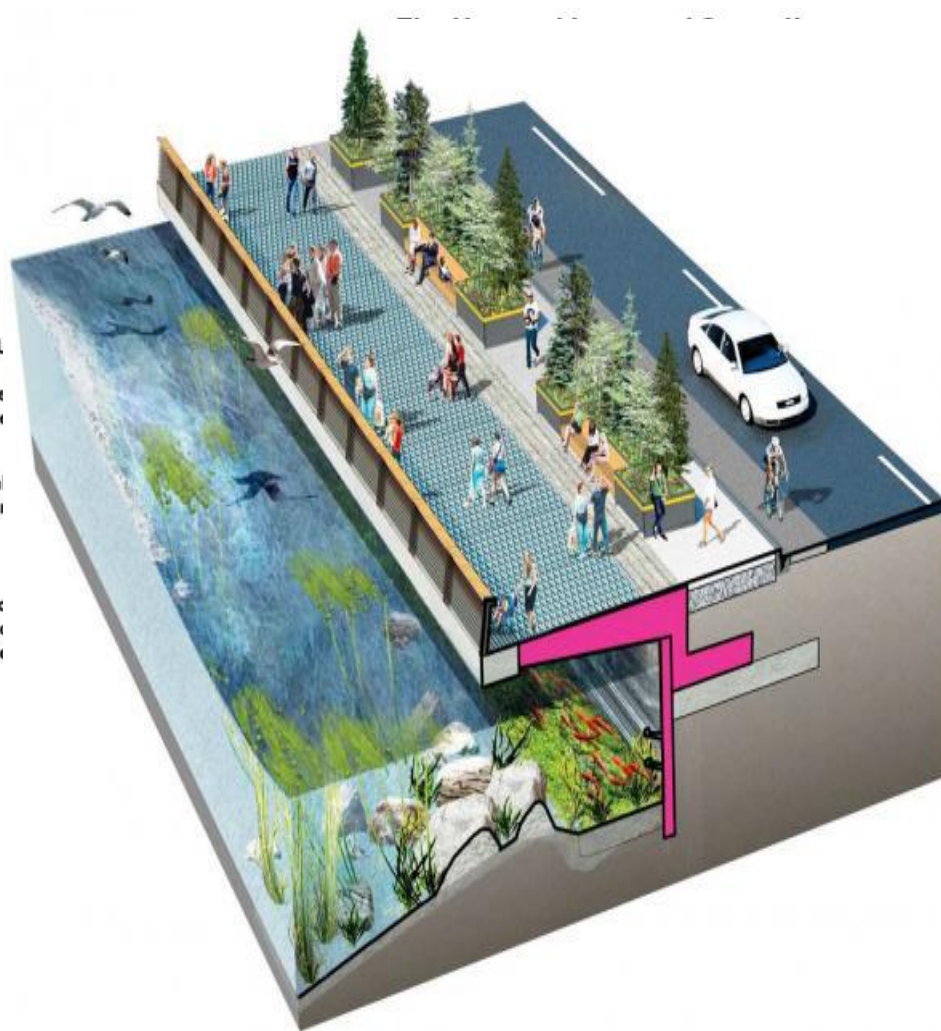


Hartlepool Headlands

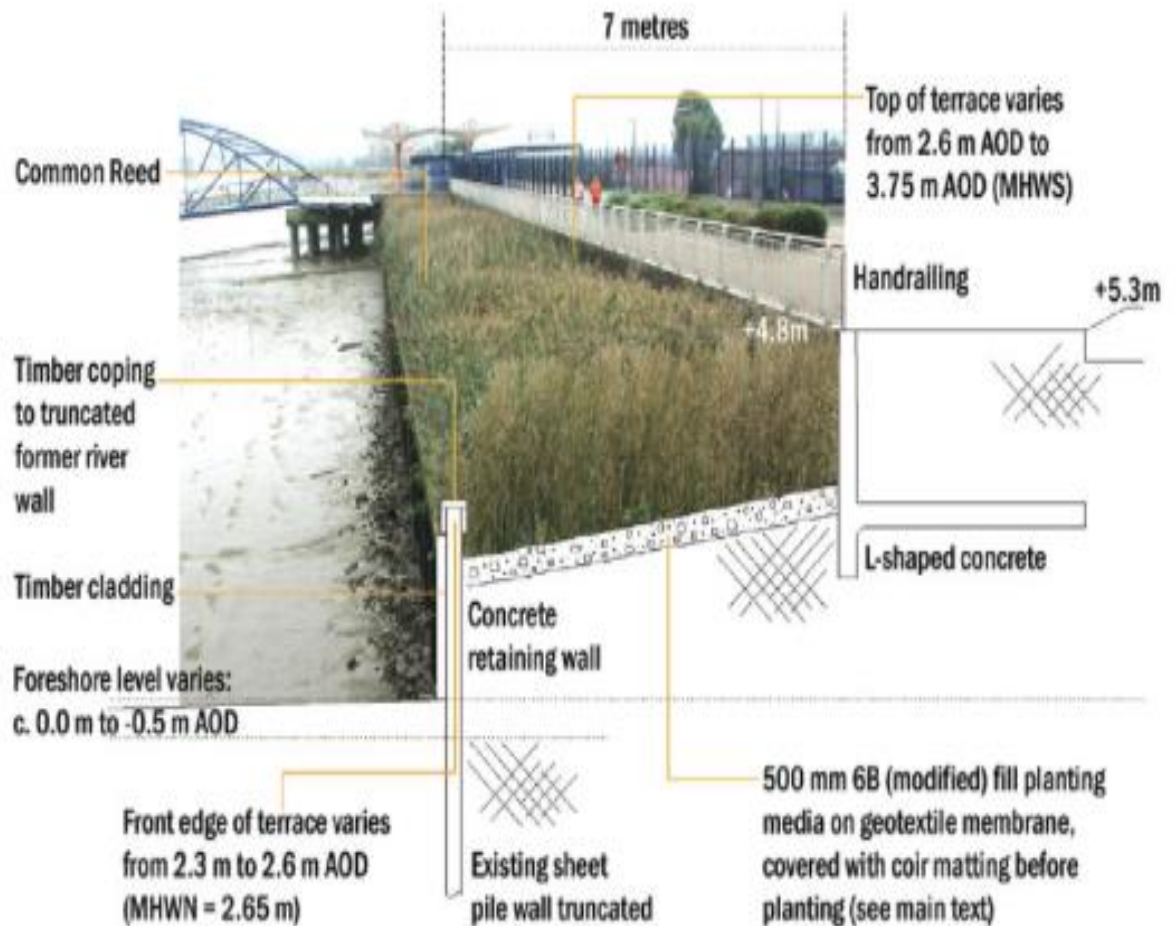
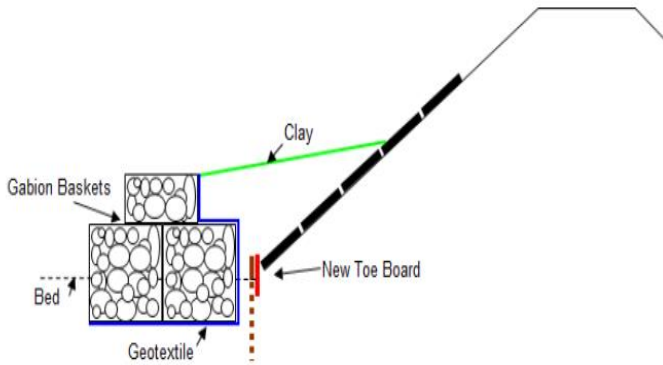
- **Driver: Habitats Directive /Ramsar Site**
- **Goal:** habitat loss mitigation for birds
- **Status:** under construction



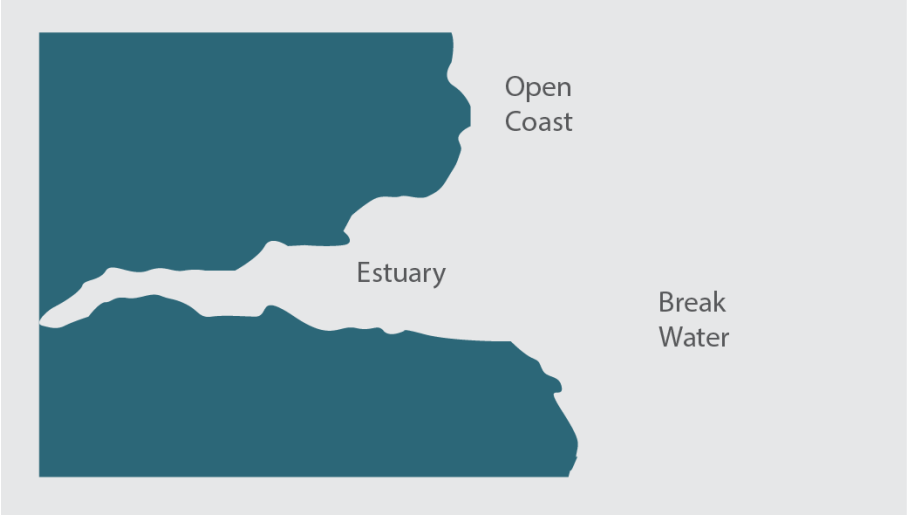
Seattle seawalls



Saltmarsh fringes



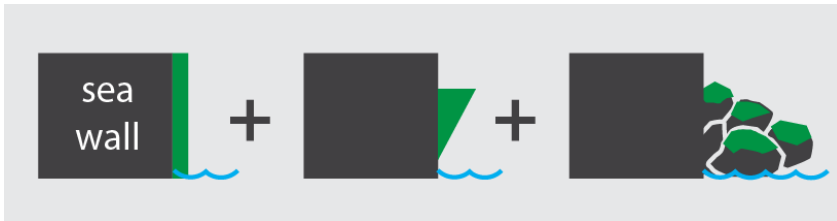
Coastal & Estuarine IGGI Measures



Vegetated fronts	CS1	CS2	CS3
Armour	CS4		
Sea walls	CS5	CS6	CS7
Other	CS8		



Coastal & Estuarine IGGI Solutions



ESTUARY (MUDDY)



COASTAL & ESTUARY (CLEAR)



Art of the Possible

Rock armour habitat - pits & grooves

Direct Costs	Much less	Life less	The same	Slightly more	Much more
BAU					
Limestone					
Granite					

Engineering
 No discernible negative impact. The size and density of these measures were on a scale not to impact on engineering performance.

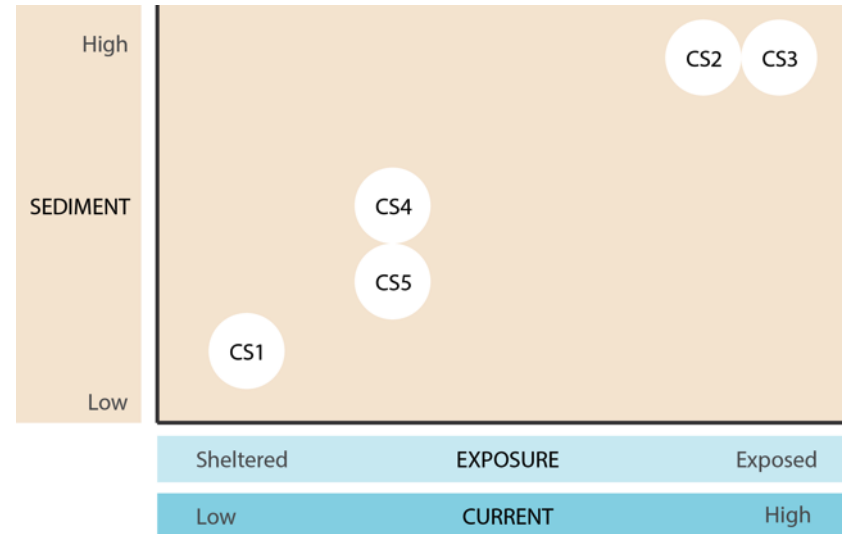
Environmental
 Both sites monitored for 12 months. 17 taxa were found in the control area compared to 30 taxa in the grooves and 19 taxa in the holes.

Limestone had higher species richness and diversity than the granite rock armour. For granite, there was a significant increase in species richness, species diversity and total abundance of individuals in both the holes and grooved treatments compared to the control. For limestone, species richness and diversity were both significantly higher in the holes and grooved treatments than the control area. Species of commercial importance (e.g. crabs) were only found in the treated areas.

Policy
 No specific mitigation requirement, the habitat creation assisted approval of the Runswick Bay scheme by Marine Monitoring Organisation and Nature England, as it is within a Marine Conservation Zone.

Further Data
 Hall et al. in review "Evaluation of Low Cost Ecological Enhancement Techniques to Improve Habitat Heterogeneity on Coastal Defence Structures". ICE 2017 proceedings.

Benefit ratio
 Negative | Neutral | Positive



Project outputs ‘bundle’ for each topic

- **Business case** high level business case per topic
- **Case studies** specific examples for each topic
- **Art of the possible** ideas for each topic

SHAUN PIMLOTT
DESIGN

NERC SCIENCE OF THE ENVIRONMENT

Business case for Coastal and Estuarine IGGI



Purpose

To create an evidence-based case to aid wider implementation of coastal and estuarine IGGI. Evidence is drawn from operational and research examples from across the UK and beyond to illustrate the range of IGGI measures and IGGI solutions that could be applied in the UK context.

When in the design /life of an asset can this be applied?

Any stage. Most effective as a strategic design goal or a mitigation requirement and/or during repairs.

Where has this innovation been tested or applied?

This business case aims to reduce uncertainties associated with GI innovation including:

- Will it work?
- Will it cost more?
- What examples are there we can draw on?
- Are the benefits worth it?
- What are the benefits?
- How can we get this approved in our own schemes?

What is it?/Greening innovation

Greening of hard coastal and estuarine infrastructure to improve biodiversity where the policy decision is 'hold the line', where greener working with natural processes (WWNP) approaches are not feasible.

What types of infrastructure have been greened using this technique?

A range of linear infrastructure including: sheet piling, seawalls, rock and concrete armour, breakwaters, piers and stormwater outfalls.

PER-URBAN TO RURAL ESTUARY



URBAN ESTUARY (MUDDY)



COASTAL & ESTUARY (CLEAR)



Business Case: Mowing for Pollinators



Purpose
To create an evidence-based case to aid wider implementation of 'mowing for biodiversity'.

This business case aims to reduce uncertainties associated with GI innovation including:

- Will it work?
- Will it cost more?
- What examples are there we can draw on?
- Are the benefits worth it?
- What are the benefits?
- How can we get this approved in our own schemes?

What is it? / Greening innovation
Change of maintenance regimes to reduce cost and improve ecosystem services without any engineering impacts. Key drivers have been to save money, to improve biodiversity and/or amenity value.

What types of infrastructure have been greened using this technique?
A range of linear and urban assets including: earth embankment flood defences, road verges, central reservations and industrial estates.

When in the design /life of an asset can this be applied?
As a strategic design goal (mowing for biodiversity) and as part of routine maintenance practice and/or as a cost saving measure.

Where has this innovation been tested or applied?



Evidence Summary

Cost	Environmental	Engineering	Data Quality
What do they cost compared to business as usual?	To improve biodiversity by providing improved grassland or wildflower meadow habitat for key pollinator species.	No risk to design life, and possible small changes to asset inspection timing. Only the maintenance regime is altered.	What is the quality of the data underpinning this bundle?
LESS	POSITIVE	NEUTRAL	MODERATE - HIGH

Evidence Summary – Secondary Drivers

Policy	Social	Corporate	Asset Resilience
To help meet national pollinator strategic objectives and/or local Biodiversity Action Plan targets for bee species	Improved amenity value, improved community cohesion (some of the schemes have involved corporate-community partnerships) and new jobs have been created (Westhorpe scheme).	Led to improvements in corporate reputation, gain public support for changes in management and won awards (Art of Possible M1). Local authority cuts and 'reduced' service provision has been offset by wildflower meadows that have high public approval.	The changed mowing practice has little adverse or beneficial effect on the structural integrity of earth embankments or verges.
ACHIEVED	POSITIVE	POSITIVE	NEUTRAL

How can you get this type of greening approved for your scheme?

The case study, art of the possible examples and policy links provided here can be used to demonstrate the economic, environmental and social benefits that can be gained from this type of IGGI innovation. What is also required is a willingness to innovate where testing or application of these innovations often requires changes in behaviour or practice.

Benefits Assessment

The evidence summary presented above is derived from the examples contained in this bundle, which have been assessed using the How to Critical Success Factors instructions developed by this project. The benefits wheel and descriptions below explain each how each critical success factor criteria was assessed and valued.



Provisioning
Pollinators are key for delivering commercial arable agriculture. Research is on-going to establish the viability of biomass renewable energy production from cropped grass.

Regulating
Semi-natural and natural habitats provide regulating services – including carbon sequestration.

Cultural
Semi-natural habitats and rich ecosystems can provide opportunities for learning, aesthetic, recreational and reflective experiences.

Supporting
The altered mowing regime improves pollinator habitat. Pollinators are essential in supporting rich ecosystems and agriculture.

Additional benefits
The success of reduced mowing and increased wildflower meadow habitat has enabled a local authority to win awards and save money.

Cost
Reduced mowing saves money.

Performance
Little or no impact on engineering performance or asset resilience.



www.sustainableedinburgh.org



hello@sustainableedinburgh.org

Edinburgh Adapts is a joint initiative of city stakeholders committed to helping Edinburgh adapt to the impacts of climate change. It is led by the Edinburgh Sustainable Development Partnership, with guidance and support provided by Adaptation Scotland.



THE EDINBURGH PARTNERSHIP

The Edinburgh Partnership is the community planning partnership for Edinburgh.

www.sustainableedinburgh.org

Adaptation
Scotland

supporting climate change resilience

Edinburgh Adapts has been supported by Adaptation Scotland. Adaptation Scotland is a programme funded by the Scottish Government and delivered by Sniffer.

www.adaptationscotland.org.uk



Sniffer is a registered charity delivering knowledge based solutions to resilience and sustainability issues.

www.sniffer.org.uk

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Next Steps

- What is happening to help Edinburgh Adapt to coastal change?
- What more needs to be done?

