

<b>Institution:</b> University of Glasgow (UofG)		
<b>Unit of Assessment:</b> UoA 7 (Earth Systems and Environmental Science)		
<b>Title of case study:</b> Coastal erosion risk: shaping national and local government risk management, adaptation and resilience policy and practice		
<b>Period when the underpinning research was undertaken:</b> 2000–2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Dr Jim Hansom	Emeritus Reader	1992–2018
Prof. Larissa Naylor	Professor	2014–present
Dr James Fitton	Research Assistant	2015–2017
<b>Period when the claimed impact occurred:</b> 2014–31 December 2020		
<b>Is this case study continued from a case study submitted in 2014?</b> No		
<b>1. Summary of the impact</b> <p>UofG research produced internationally recognised tools, guidance and evidence on coastal erosion for Scottish Government and its agencies. This included the award-winning DynamicCoast, that shows coastal erosion has risen by 39% since the 1970s, with 20% of Scotland's coastal homes (GBP524 million) now at risk. Scottish Government, its agencies, and businesses, use this research to design and implement policies that address coastal erosion, assess risk and achieve their statutory flood, erosion, climate change and adaptation obligations. These adaptation plans, climate-resilient planning and marine licensing decisions have improved the resilience of Scotland's coastal communities and assets. In 2020 DynamicCoast was acknowledged by the Scottish Government as their stimulus for GBP12 million investment in new central funding for Coastal Change Adaptation.</p>		
<b>2. Underpinning research</b> <p>UofG research has provided the evidence base, tools and guidance to allow local and national government to respond to the risk posed by coastal erosion and erosion-related flooding (hereafter, coastal erosion). The research has established that 19% (3,802km) of Scotland's 20,000km coast is soft and increasingly vulnerable to coastal erosion as sea levels rise, negatively impacting both the coast and the assets and communities behind. This puts at risk more than 9,000 buildings, 500km of roads, 300km of water supply lines, 60km of rail track, and vital airport runways that are currently protected by natural defences (e.g. beaches/dunes).</p> <p>Since 2011, UofG coastal geomorphology has involved fieldwork, modelling and Geographic Information System (GIS) analysis of sea level rise and erosion rates across Scotland. These underpinned the development of a pan-Scotland coastal erosion and flooding susceptibility model [Ref 3.1], supported by an Engineering and Physical Sciences (EPSRC) Collaborative Award in Science and Engineering PhD studentship (Fitton, 2011–2015) with Scottish Natural Heritage (SNH), that modelled the natural susceptibility of the Scottish coast to erosion [Ref 3.1]. The Scottish Environment Protection Agency (SEPA), recognising its lack of tools to assess the national risk of coastal erosion, supported Hansom (PI) and Fitton (RA) to further develop this work and produce a national Coastal Erosion Susceptibility Model (CESM). This identified assets vulnerable to coastal erosion, to allow more effective management at multiple statutory policy levels across Scotland.</p> <p>Recognising the potential of the UofG CESM model, Scottish Government (SG) commissioned Hansom (PI), Fitton (RA) and SNH/SG coastal erosion coordinator (Rennie) to develop a national coastal change assessment (NCCA, now called DynamicCoast; <a href="http://www.dynamiccoast.com">www.dynamiccoast.com</a>), an evidence-based GIS for SG and its agencies to assess coastal risk [Ref 3.2]. DynamicCoast used 2,000 maps and 1 million data points to provide a detailed risk assessment of the vulnerability of Scotland's coast.</p> <p>DynamicCoast [Ref 3.2] identified ~3,300 homes with a combined value of GBP524 million at high risk of erosion. Notably, the work established that, since the 1970's, the erosion extent has increased by 39% with a doubling of the average erosion rate to 1m per year, compared to the period 1890's to 1970's [Ref 3.2]. Due to the impact of DynamicCoast [3.1-3.3], SG funded (via</p>		

Scotland's Centre of Expertise for Waters (CREW)) Hansom (PI) and Naylor (Co-I) to deliver DynamicCoast2 (2018–2021). This modelled anticipated future coastal change to enable the development of accurate risk and adaptation plans for those communities most vulnerable to coastal erosion.

In parallel with the above, Naylor and Hansom collaborated with Arup to assess climate change risks in the Firth of Clyde for SNH [Ref 3.4] and, later in 2016, with the City of Edinburgh by adding coastal actions to the “Edinburgh Adapts” Action Plan. Further evidence of UofG coastal geomorphology expertise is Naylor’s co-lead on “Stormy Geomorphology”, an international research initiative that identified the impact of climate change on landscapes and society [Ref 3.5]. A Belmont Forum/Natural Environment Research Council (NERC) project (2013–2017) allowed Naylor to identify social and political influences on climate change adaptation, and policy windows to support coastal adaptation [Ref 3.6] through a NERC (2015–2019) Knowledge Exchange fellowship. Naylor leads the adaptation component of DynamicCoast2 and has led the EPSRC IAA-funded Edinburgh Downscaling project (2019–2020), which combined [Ref 3.1, 3.2, 3.3] to create an Urban Coastal Erosion Susceptibility Model (U-CESM).

### 3. References to the research

- 3.1 \* Fitton, JM, **Hansom**, JD, & Rennie, AF. (2016) A national coastal erosion susceptibility model for Scotland. *Ocean & Coast. Mgmt*, 132, 80–89 ([doi:10.1016/j.ocecoaman.2016.08.018](https://doi.org/10.1016/j.ocecoaman.2016.08.018))
- 3.2 **Hansom**, JD, Fitton, JM, and Rennie, AF. (2017) Dynamic Coast – National Coastal Change Assessment: National Overview, CRW2014/2, GIS tool and reports: [www.dynamiccoast.com/outputs.html](http://www.dynamiccoast.com/outputs.html)
- 3.3 \* Fitton, JM, **Hansom**, JD, & Rennie, AF. (2018) [A method for modelling coastal erosion risk: the example of Scotland](#). *Natural Hazards*, 91, 931–961 ([doi:10.1007/s11069-017-3164-0](https://doi.org/10.1007/s11069-017-3164-0))
- 3.4 **Hansom**, JD, Maxwell, F, **Naylor**, LA, & Piedra, M. (2017) [Impacts of Sea-Level Rise and Storm Surges Due to Climate Change in the Firth of Clyde](#). Research Project Report CR891. Scottish Natural Heritage, Inverness: [www.nature.scot/snh-commissioned-report-891-impacts-sea-level-rise-and-storm-surges-due-climate-change-firth-clyde](http://www.nature.scot/snh-commissioned-report-891-impacts-sea-level-rise-and-storm-surges-due-climate-change-firth-clyde)
- 3.5 **Naylor**, LA, Spencer, T, et al. (2017) [Stormy Geomorphology: geomorphic contributions in an age of climate extremes](#). *Earth Surf. Proc. and Land*. 42, 166–190 ([doi:10.1002/esp.4062](https://doi.org/10.1002/esp.4062))
- 3.6 Brown, K, **Naylor**, LA & Quinn, T. (2017) [Making space for proactive adaptation of rapidly changing coasts: a windows of opportunity approach](#). *Sustainability*, 9(8), 1408 ([doi.org/10.3390/su9081408](https://doi.org/10.3390/su9081408))

\* = best indicators of quality

### 4. Details of the impact

UofG research has delivered evidence-based tools that enable national and local governments, and their agencies, to implement policies that address coastal erosion and assess risk. This has catalysed a step change in coastal erosion policy, strategy and practice, improving the future resilience of coastal communities and assets [5.1a(i)]. The reach of DynamicCoast is global: 65,440 website hits and 16,660 users from 105 countries since August 2017 ([dynamiccoast.com](http://dynamiccoast.com)).

**A. Changes to National Policy:** UK government requires 5-yearly Climate Change Risk Assessments (CCRAs) under the UK Climate Change Act, with “CCRA1 noted the absence of coastal change analysis between historical mapping and modern datasets” [5.1c, p33]. UofG research addressed this key evidence gap, producing tools which allow policy makers better manage those risks. The Scottish Government has, through both the Scottish Climate Change Adaptation Programme (SCCAP) [5.1b] and SCCAP2, used UofG research [3.3] to identify the coastal erosion risks noting that “...GBP1 billion roads, GBP 2 billion railway line and GBP0.5 billion housing within land...susceptible to coastal erosion”. They also confirm that UofG’s tools allow the Scottish Government to better manage these risks: “Use the [Coastal Erosion Susceptibility Model] CESM for Scotland to inform Flood Risk Management Plans” [5.1d, §N2-

20, p55]. Thus, UofG research has addressed these evidence gaps, enabling production of *“the first full assessment of [Scotland’s] coastal vulnerabilities”* [5.1b]. UofG research has driven Scottish Government’s decision to invest GBP12 million [5.1a(1)] in new central funding for coastal change adaptation. The UK Parliament’s Preparing for Climate Change Progress Report states *“NCERM data are not available in an easy-to-use format; Scotland’s Dynamic website shows that this is possible, and a similar approach should be adopted in England”* [5.1e]. Internationally, Ireland’s statutory adaptation plans recommend DynamicCoast as *“best-practice exemplar that Ireland can follow”* [5.1f].

**B. Changes to Regional/Local Policy:** The UofG CESM [3.2] is used by SG agencies [5.2–5.3] responsible for flooding (SEPA), marine (Marine Scotland), nature (SNH), historic environment (Historic Environment Scotland, HES) and 25 (of 32) local authorities. HES and SNH use DynamicCoast to underpin technical guidance for the historic environment [5.3a] and in national advice for planners [5.3b]. SEPA has embedded UofG-developed outputs [3.1, 3.3] into flood webmaps (NSCE maps) to *“inform which actions are likely to be more sustainable to manage coastal flood risk... (and)...inform strategic advice provided by SEPA.”* [5.2a]. Indeed *“As coastal erosion and flooding are interlinked, they must be considered jointly. SEPA has used outputs from the Dynamic Coast project to inform the second National Flood Risk Assessment published in December 2018”* [5.2c, §2.3].

DynamicCoast and the NSCE maps enable SEPA to fulfil statutory legislative requirements previously unaddressed (§19-21 2009 Flood Risk Management (Scotland) Act), impact recognised by the Scottish Knowledge Exchange Award’s ‘Spotlight’ prize in 2019 [5.4]. SEPA’s Head of Hydrology and Flooding notes: *“Dynamic Coast data and analysis is highly relevant to the appraisal of actions to address flood risk...”* [5.2b, pg2]; underpinned by these coastal erosion data, flood risk appraisals are more robust and improve future community and infrastructure resilience.

Four Local Authorities (Ayrshire, Fife, Moray and Highland) have used DynamicCoast for coastal erosion and climate change risk assessment within Shoreline Management Plans (SMP), with more expected to follow [confirmed by 5.5 and the Scottish Government Managing Flood Risk Team, 5.1a(i)]: *“The Dynamic Coast project has had a truly transformative impact...in support of our local communities.... Awareness of the risks identified within these maps is essential as Scotland embarks on resilience and adaptation planning along asset-rich shores....”* [5.1a(i)].

Through her Knowledge Exchange fellowship, Naylor was able to influence policy at city and regional scale in Scotland (Adaptation Scotland and Clyde Marine Planning Partnership) and England. UofG coastal actions, within Edinburgh’s climate change adaptation plan, allow statutory climate change adaptation duties to be met [5.5d]. Coastal policy in the Clyde Marine Plan [5.5e(ii), Chapter 4] are UofG-driven, confirmed by the Marine Plan Manager [5.5e(i)]: UofG *“coastal research ([3.2]; [3.4]) has been a key input to allow us to develop... those aspects relating to sea-level rise, coastal processes and adaptation management...”*.

**C. Changes to government/industry practice improving coastal resilience:** DynamicCoast has driven practice-change within SG agencies. Marine Scotland’s License Operations Team (MS-LOT) use DynamicCoast to ensure marine license compliance with the Marine (Scotland) Act 2010 [5.3c]: *“DynamicCoast maps have enabled MS-LOT to more easily consider the potential impacts to or from coastal erosion. It has become standard practice to review the maps when considering applications for dredging”*, such as at Montrose [5.6, pp43–44].

Statutory consultee, SEPA, used DynamicCoast to prevent a substantial housing development in an erosion risk site, placing it on indefinite hold [5.2d, §1.5]: *“Dynamic Coast was referenced in our consultation response for a proposed residential and leisure development at Ardersier, Nairn”* [5.2b, p3]. In Edinburgh, UofG research [3.2, 3.3, 3.6] underpins the business case for creating a coastal park and landward relocation of a 3,500-house regeneration project [5.5d(i)].

Coastal businesses also directly use DynamicCoast; world-renowned golf courses such as St. Andrews use UofG data to plan repairs and/or improve climate-resilient business continuity [5.7]. Energy infrastructure is now more resilient: landfalls from proposed offshore renewables were moved to a risk-free site, eg: *“Moray Council uses DynamicCoast to inform future development...important in reducing the risk of inappropriate development”* [5.5c(i)–(ii)]. Such

changes improve business sustainability by better managing coastal erosion risks and reducing future costs.

**D. Integration of research methodology into National Practice:** In 2017, Ordnance Survey Ltd (OS) adopted DynamicCoast's innovative methodology to change its data attributions and protocols, improving the accuracy of its tidal surveying [5.8]. Mean High Water Springs (MHWS) constitute the legal land registry boundary underpinning coastal title in Scotland, and DynamicCoast has ensured challenge-free OS tideline positions. This is confirmed by the Managing Director, National Mapping Services [see 5.8]: *"These tidal updates greatly enhance the robustness of other key OS products such as Boundary-Line, which represents the hierarchy of administrative and electoral boundaries in England, Scotland and Wales and supports a wide range of government and business decisions."* Dynamic Coast change in Scotland 'informed the need for a targeted GB-wide coastal revision programme. As a result...OS...update(d) 5,700km of MHWS and associated geographic features in England and Wales to December 2020" [5.8]. Marine Scotland's Licensing Operations Team noted: *"An additional benefit of the work of DynamicCoast has been the updating of the position of MHWS...This allows MS-LOT to provide better advice...when marine licences are required"* [5.3c].

## 5. Sources to corroborate the impact (uploaded as PDFs where possible)

### A. Changes to National Policy

#### 5.1: Government Sources (locations bookmarked in PDFs)

5.1a. (i) Letter, Scottish Government Managing Flood Risk Team (PDF); and (ii) Scottish Government Launch of DynamicCoast (see 03:25-04:25 at: [www.youtube.com/watch?v=EXnJcXB1G3c&feature=youtu.be](http://www.youtube.com/watch?v=EXnJcXB1G3c&feature=youtu.be)) (MP4 file available on request from HEI)

5.1b. Scottish Climate Change Adaptation Programme (2019) (SSCAP), multiple pages refer to NCCA and Dynamic Coast: [www.theccc.org.uk/publication/final-assessment-of-scotlands-first-climate-change-adaptation-programme/](http://www.theccc.org.uk/publication/final-assessment-of-scotlands-first-climate-change-adaptation-programme/)

5.1c. UK Climate Change Risk Assessment (CCRA) Evidence Report – Summary for Scotland (2017), pp.33 and 44: [www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Scotland-National-Summary.pdf](http://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Scotland-National-Summary.pdf)

5.1d. Scottish Climate Change Adaptation Programme (SCCAP, 2015), section N2–20, pg.55 : [www.gov.scot/publications/climate-ready-scotland-scottish-climate-change-adaptation-programme/pages/4/](http://www.gov.scot/publications/climate-ready-scotland-scottish-climate-change-adaptation-programme/pages/4/)

5.1e Committee on Climate Change 2019 Report to Parliament: Progress in Preparing for Climate Change, pg138. [www.theccc.org.uk/publication/progress-in-preparing-for-climate-change-2019-progress-report-to-parliament/](http://www.theccc.org.uk/publication/progress-in-preparing-for-climate-change-2019-progress-report-to-parliament/)

5.1f. Irish Government. Built & Archaeological Heritage Climate Change Sectoral Adaptation Plan (2019), Section 5.1.4.3: [assets.gov.ie/75639/a0ad0e1d-339c-4e11-bc48-07b4f082b58f.pdf](http://assets.gov.ie/75639/a0ad0e1d-339c-4e11-bc48-07b4f082b58f.pdf)

### B. Changes to Regional and Local Policy

#### 5.2: Scottish Environment Protection Agency (locations bookmarked in PDFs)

5.2a. SEPA maps (2015) <http://map.sepa.org.uk/floodmap/map.htm>, and see section 2: <https://www.sepa.org.uk/media/163411/natural-susceptibility-to-coastal-erosion-summary.pdf>)

5.2b. Letter, SEPA Head of Hydrology & Flooding (PDF).

5.2c. SEPA: National Flood Risk Assessment (NFRA) (2018) (see Section 2.3): [www2.gov.scot/Publications/2019/02/2281/6](http://www2.gov.scot/Publications/2019/02/2281/6)

5.2d. SEPA: Nairn Statutory Consultee Response, see Section 1.5 (PDF).



5.3a. Historic Environment Scotland (2019). A Guide to Climate Change Impacts, p41:  
<https://pub-prod-sdk.azurewebsites.net/api/file/40e3b1f5-05c9-417a-a5e3-aae0008d342d>

<https://www.nature.scot/sites/default/files/2019-05/Planning%20ahead%20for%20coastal%20change%20guidance.pdf>

**5.4: Scottish Spotlight Impact Award 2019** Press Release (see: Spotlight Award, bookmarked in PDF): [interface-online.org.uk/news/winners-4th-scottish-knowledge-exchange-awards-announced](https://interface-online.org.uk/news/winners-4th-scottish-knowledge-exchange-awards-announced)

[ayrshire.gov.uk/community-safety/flooding/ayrshire-shoreline-management-plan.aspx](http://www.ayrshire.gov.uk/community-safety/flooding/ayrshire-shoreline-management-plan.aspx)

[www.angus.gov.uk/sites/angus-cms/files/SMP2%20Main%20Document%20FINAL.pdf](http://www.angus.gov.uk/sites/angus-cms/files/SMP2%20Main%20Document%20FINAL.pdf)

[www.moray.gov.uk/minutes/data/RX20171215/App%202.5-Environment.pdf](http://www.moray.gov.uk/minutes/data/RX20171215/App%202.5-Environment.pdf)

5.5e. Clyde Marine Plan: (i) Letter from Clyde Regional Marine Plan Manager (PDF) and (ii) Clyde Marine Plan Pre-consultation Draft, see Ch.4 (UofG co-wrote Policies CP1-4): [www.clydemarineplan.scot/wp-content/uploads/2019/06/Pre-consultation-draft-Clyde-Regional-Marine-Plan-18-March-2019.pdf](http://www.clydemarineplan.scot/wp-content/uploads/2019/06/Pre-consultation-draft-Clyde-Regional-Marine-Plan-18-March-2019.pdf)

**5.6:** Coastal change/erosion and flood risk in Montrose; Scottish Government briefing, see pp.43-44: [gov.scot:document](http://gov.scot/document) ([www.gov.scot](http://www.gov.scot)) (location bookmarked in PDF)

#### **D. Integration of research into national practice**

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