

# Coastal Resilience to Flood and Erosion Hazard: A Demonstration for England

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# CoastalRes: Project Background

- A 1-year project funded by NERC to develop and demonstrate prototype methods to assess realistic pathways for strategic coastal erosion and flood resilience in the light of climate change, including sea-level rise
- One of a diverse set of 19 projects funded by the Strategic Priorities Fund: UK Climate Resilience
- Duration: 1 February 2019 to 31 January 2020
- Synergistic with SMP2 Refresh, but going well beyond it





# CoastalRes: Project Team and Partners

## Southampton:

- Robert Nicholls (PI)
- Ian Townend
- Emma Tompkins
- Eli Lazarus
- Ivan Haigh
- Sally Brown
- Natalie Suckall
- Chris Hill
- Stephen Carpenter

## UCL:

- Jon French

## Middlesex:

- Edmund Penning-Rowsell

## Partners

- ABPmer
- Coastal Group Network
- National Trust
- RSPB
- Wildfowl and Wetlands Trust
- National Flood Forum
- Natural England
- Network Rail

## Channel Coastal Observatory

- Charlotte Thompson





# Risk-Based Flood and Erosion Management is Well Established

## How can we operationalize resilience for coastal erosion and flood hazard management?

- Resilience is widely seen as an important attribute of coastal systems and, as a concept, is increasingly prominent in national policy documents.
- But ... there are conflicting ideas on what constitutes resilience and its operationalisation as an overarching principle of coastal management remains limited.
- We show how resilience to coastal flood and erosion hazard could be *measured* and *applied* within policy processes, and demonstrate a new Coastal Resilience Model (CRM) using England as a case study.
- Key insights concern the process rather than the outcomes



# Resilience language in national policy documents

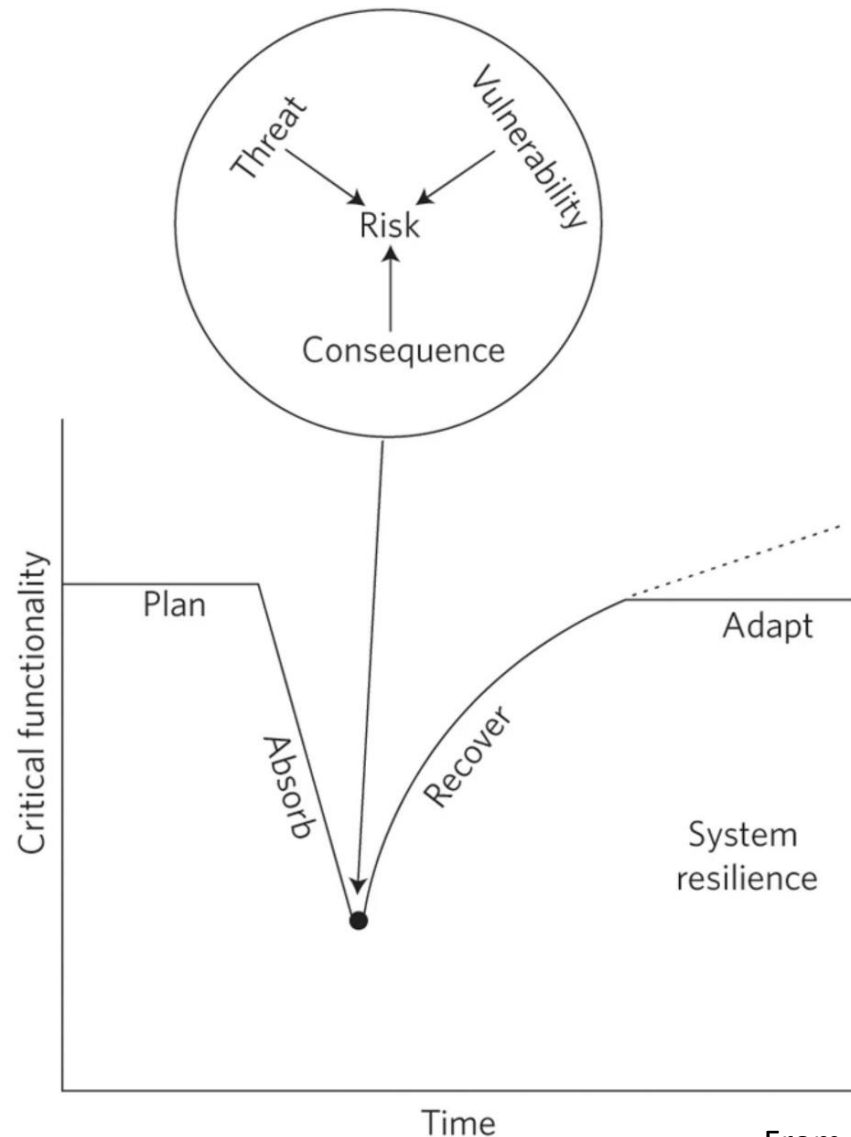
Document	Author (year)	Use of 'resilien*'(# mentions)	Definition of resilience (Y/N)
Guidance on 'Flood and Coastal Resilience Partnership Funding	DEFRA (2011a)	3	N
Understanding the risks, empowering communities, building resilience	DEFRA, (2011b)	24	Y
Flood Resilience Community Pathfinder Evaluation Final Evaluation Report	DEFRA (2015)	746	Y
National Flood Resilience Review 2016	HMG (2016)	108	N
Rising to the Climate Crisis. A Guide for Local Authorities on Planning for Climate Change	RTPI (2016)	57	N
Managing the coast in a changing climate	CCC (2018)	21	Generally – N (PLR – Y)
Public Summary of Sector Security and Resilience Plans	Cabinet Office (2018)	113	Y
The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting	DEFRA (2018)	270	Y (annex 2)
Draft National Flood and Coastal Erosion Risk Management Strategy for England	EA (2019)	210	Y

PLR = Property Level Resilience

Analysis by Emma Tompkins (Southampton)



# Resilience is a broader concept than risk



US Army Corps of Engineers (Rosati et al. 2015) defines resilience as:

“the ability of a system to prepare, resist, recover, and adapt to disturbances in order to achieve successful functioning through time”

Context is important - it is essential that the conceptual definition adopted should be framed by the questions ‘resilience against what?’ and ‘resilience for whom?’

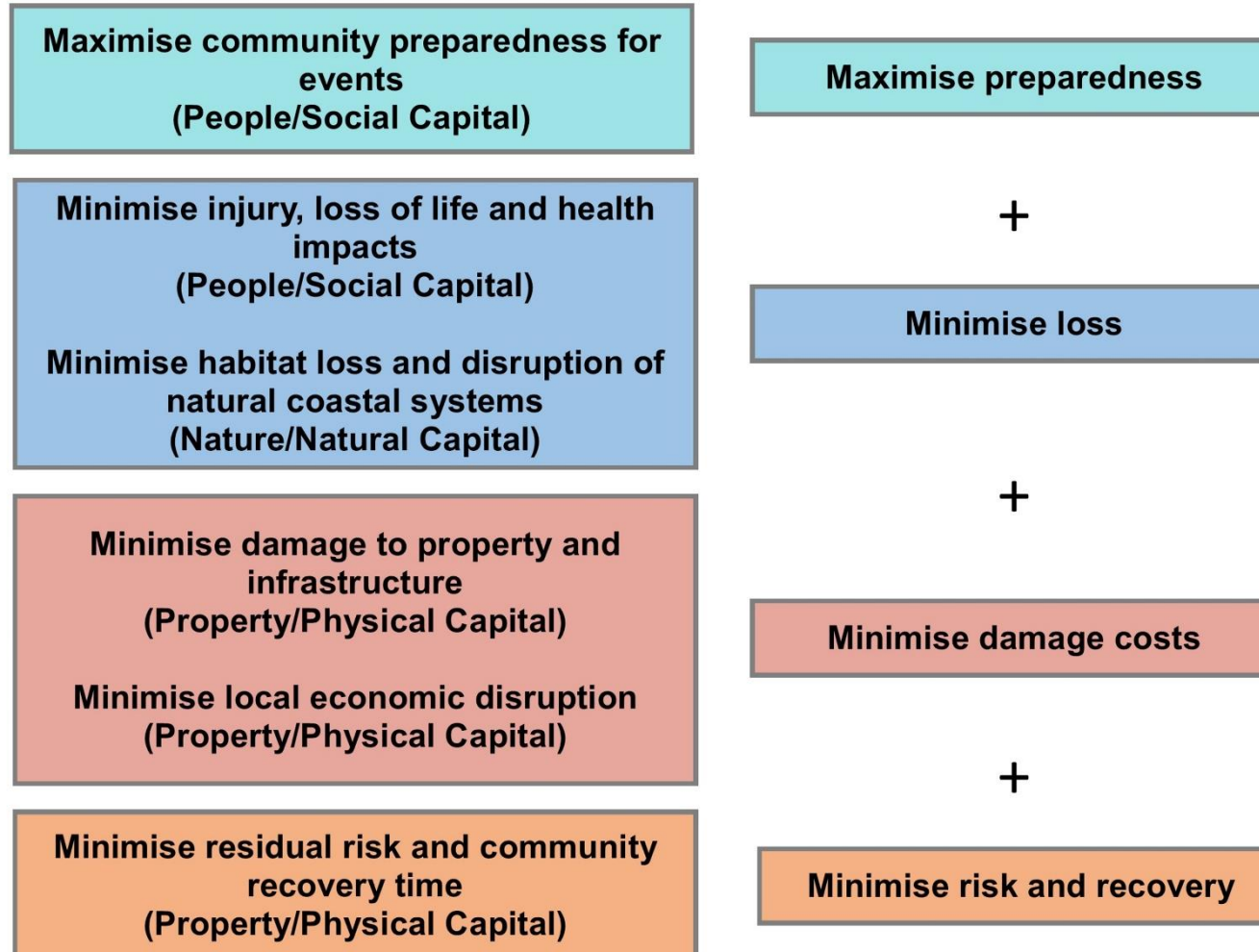


# How can we *enhance* resilience?

- The coastal systems of interest encompass landforms, ecosystems, socio-economic systems and engineered infrastructural systems.
- Flooding and erosion hazards interact but exhibit different spatial and temporal footprints - we need to capture the state of a set of coupled sub-systems that are typically described in different ways and from fundamentally different perspectives.
- *Enhancing* the resilience of these systems requires a transition from the present largely qualitative notion to a quantitative evidence-based framework.
- We do not need to define these complex systems in any absolute sense - we simply need to identify actions that will enhance the state of resilience.
- For this we define a set of objectives, which encapsulate actions that maximise the capacity to cope or minimise the potential for loss.



# Objectives that enhance coastal resilience by maximizing the capacity to cope, and minimizing the potential for loss





# Developing a decision-making framework

The initial steps in developing a policy or decision-making framework revolve around *clarity of purpose*, identification of the *options* available for implementation, and clear *performance measures*. Therefore, the first steps needed to develop coastal resilience policies can be summarised as:

1. Establish the decision-making context (policy aims, decision-makers, key stakeholders).
2. Identify clear objectives that are specific, measurable, agreed, realistic and time dependent (i.e. SMART).
3. Define the available options that can realistically address the objective(s).
4. Design a method to evaluate likely outcomes and measure performance.



# Decision-making framework: objectives and sub-objectives

High level agendas	Coastal Resilience Objectives	Sub-objectives
Human health	Maximise human health	Minimise (i) loss of life, (ii) injury, (iii) health impacts
Human assets	Minimise damage	Minimise damage to (i) property and (ii) infrastructure
Residual risk	Minimise response time	-
	Minimise recovery time	-
	Minimise displacement	Minimise for (i) flooding and (ii) erosion
Economy	Minimise damage to economy	Minimise (i) local and (ii) national damage (including supply chain impacts)
Natural assets	Minimise habitat loss	-
	Minimise disruption of natural systems	-
Community preparedness	Maximise preparedness	Use (i) warnings and awareness, (ii) monitoring and maintenance
	Minimise exposure to risk	Minimise exposure by (i) avoidance, (ii) protection, (iii) limiting residual risk, and (iv) limiting financial impact
	Maximise social acceptance	-

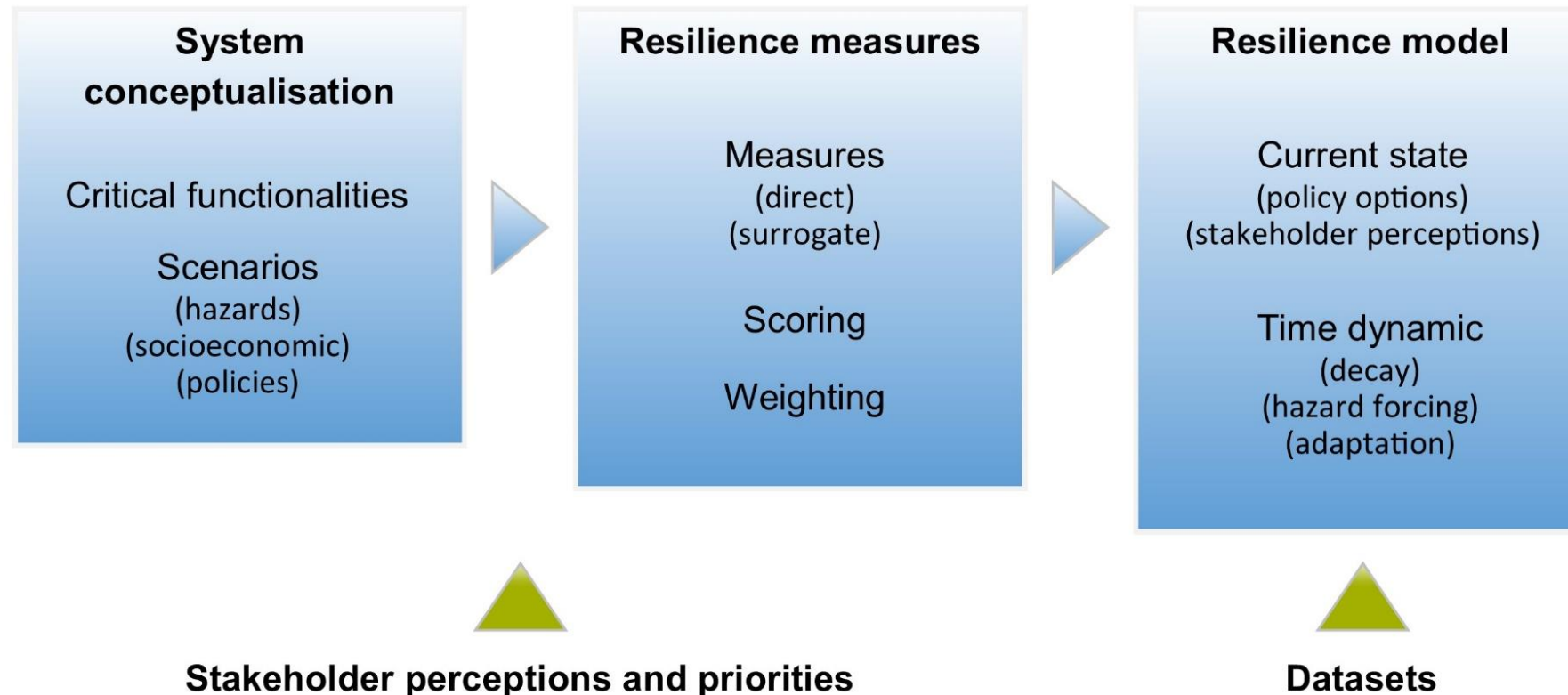






# Workflow for prototype Coastal Resilience Model based on Multiple Criteria Analysis (MCA).

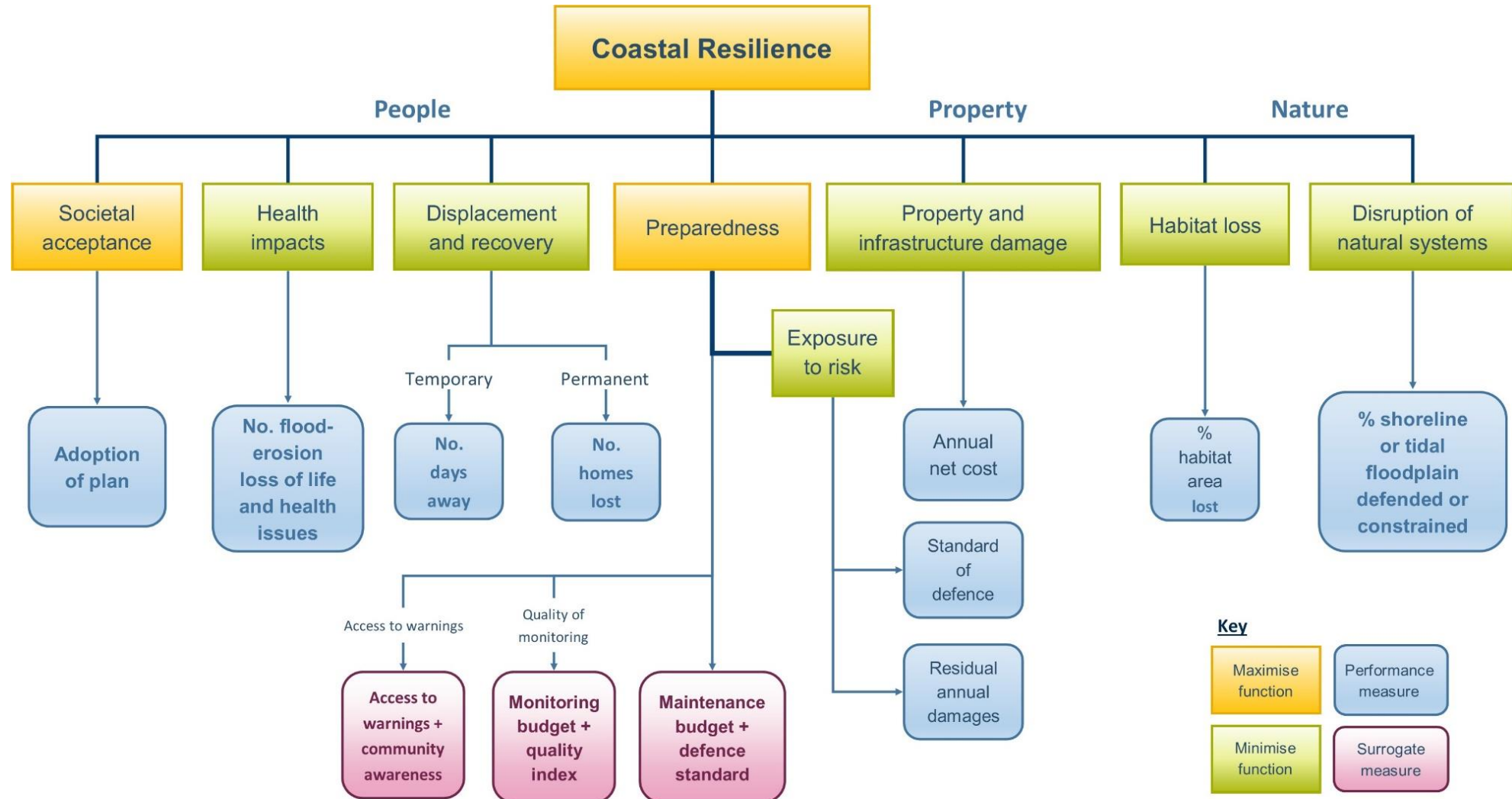
With explicit representation of stakeholder perceptions and priorities  
and timelines of change/pathways of adaptation





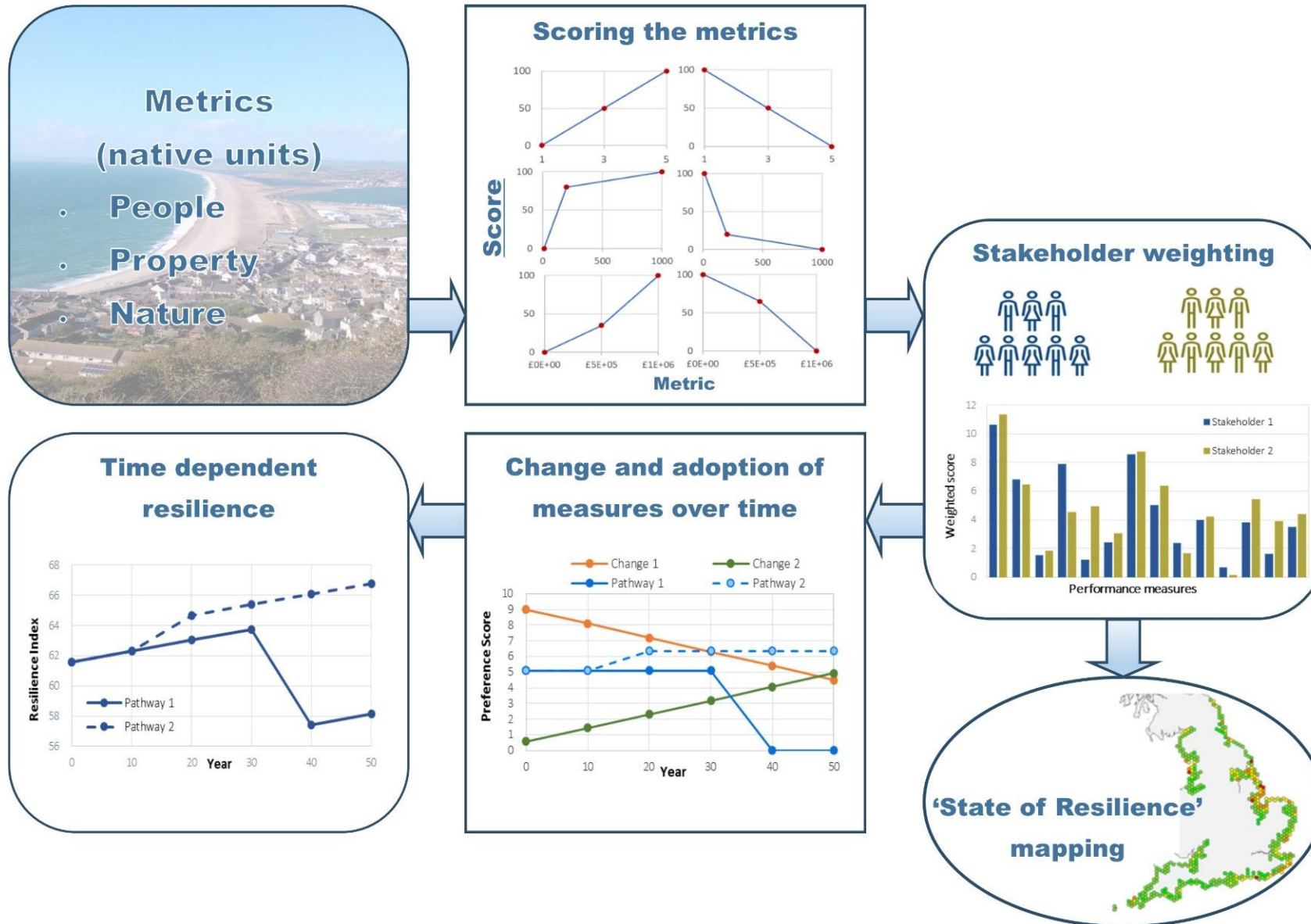
Objectives to be maximised or minimised to enhance coastal resilience.

## Quantified using indicators and associated data-driven metrics



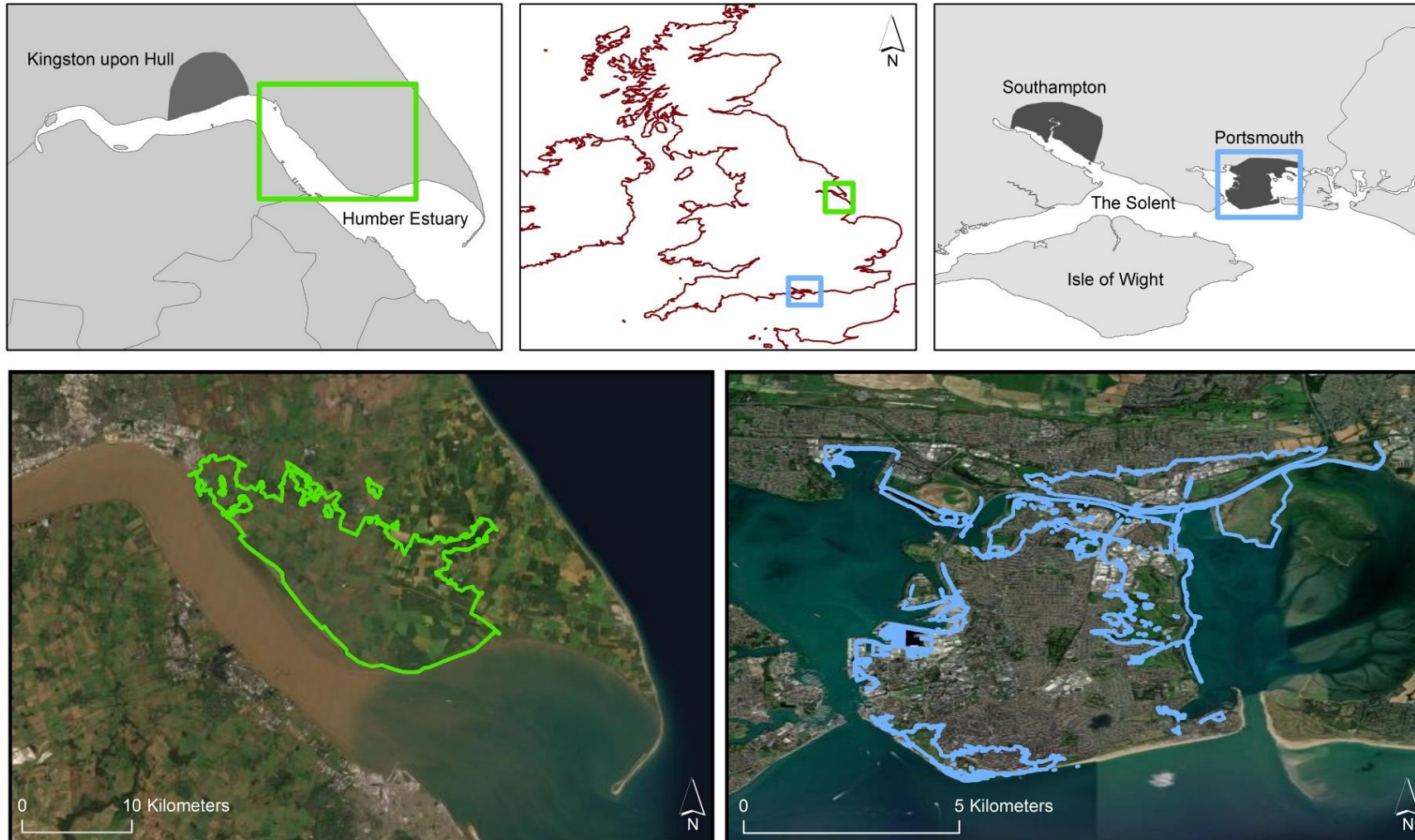


# Schematic derivation of the Resilience Index, $RI$





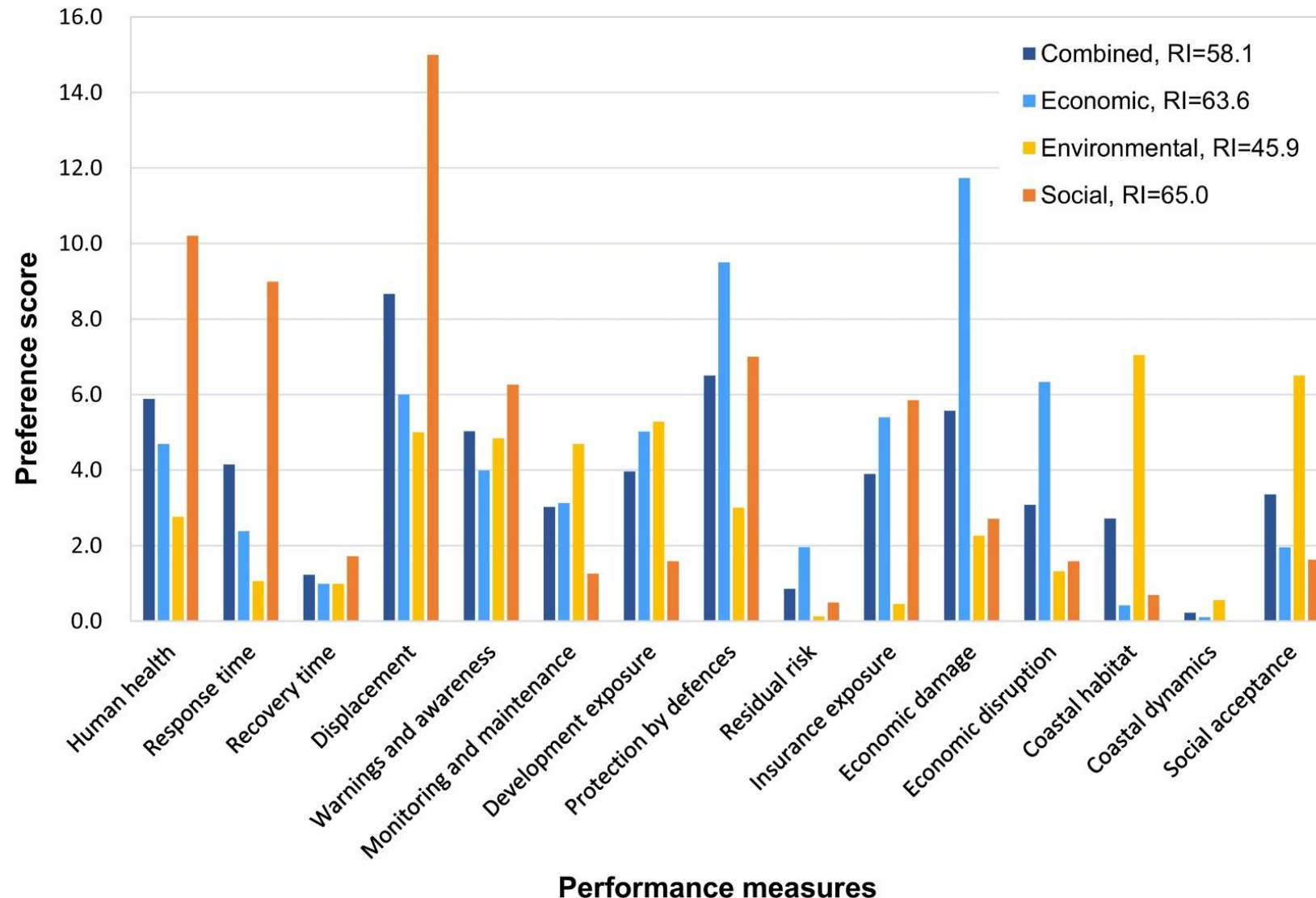
# Application of the CRM at a local scale: Portsmouth and Outer Humber case studies



Satellite images Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

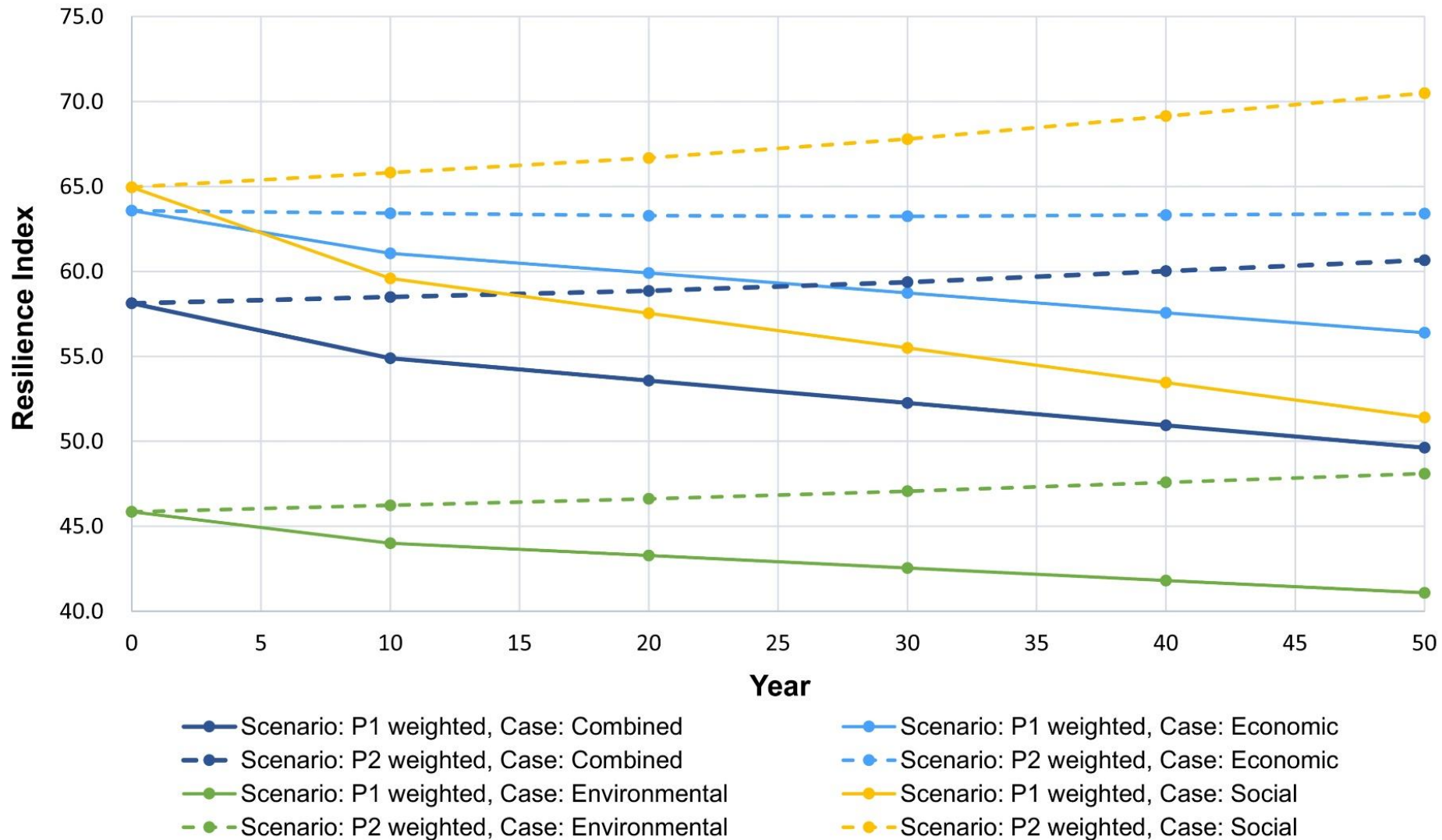


# Preference scores for Portsmouth with weights based on social, economic and environmental perspectives, and a combined average perspective





# Time evolution of the coastal Resilience Index for Portsmouth under two illustrative Adaptation Pathways (P1 and P2)

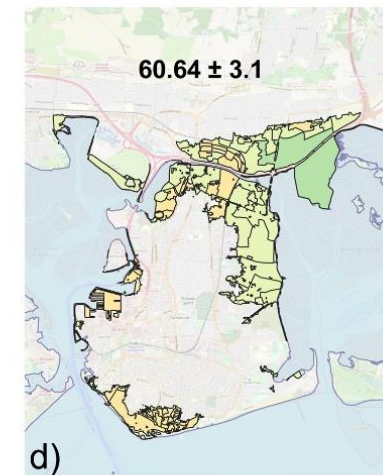
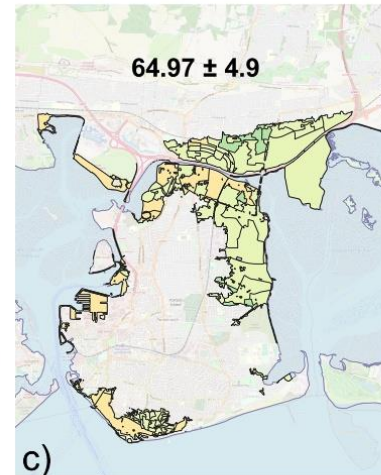
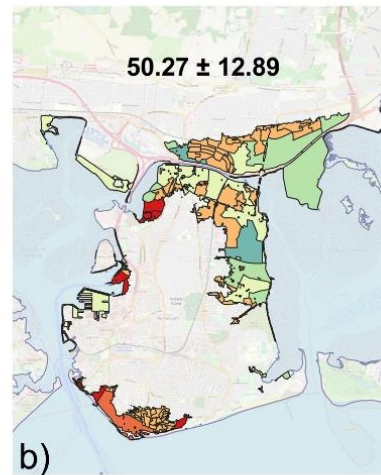
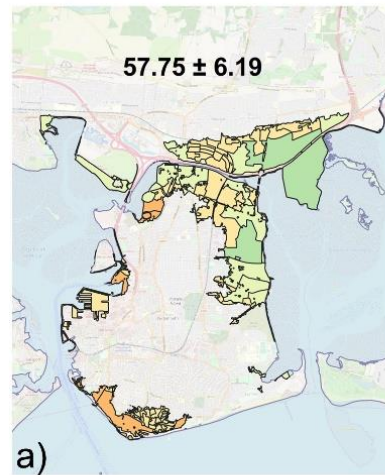


P1 assumes some loss of defence standard due to sea-level rise, thereby increasing the residual risk. P2 emphasises a well-rehearsed emergency response plan, and increasing public awareness and provision of flood proofing over time.

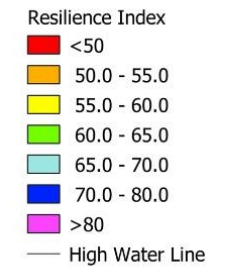
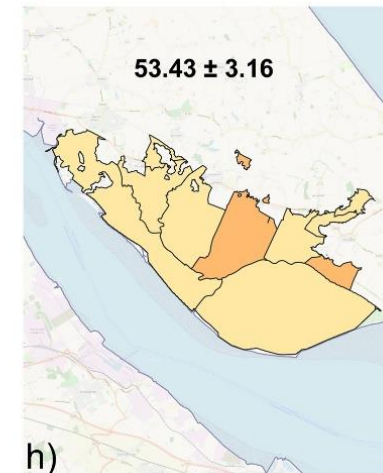
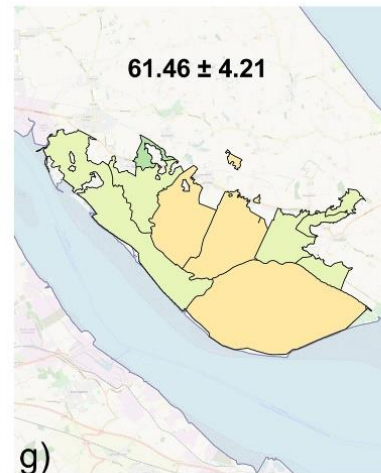
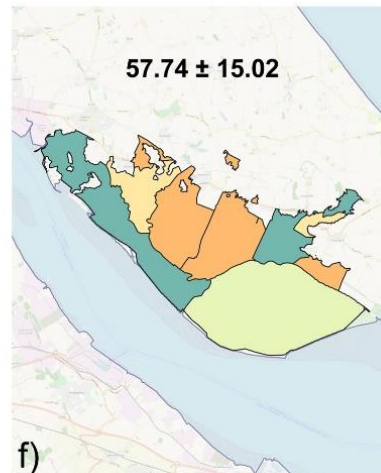
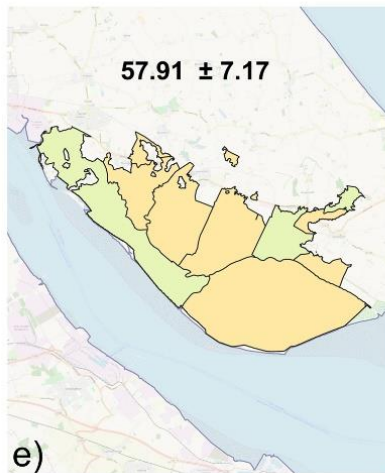


# Portsmouth and Humber Case Studies showing Resilience Index for each output area and the average RI scores

Portsmouth



Outer Humber



Combined

Environmental

Economic

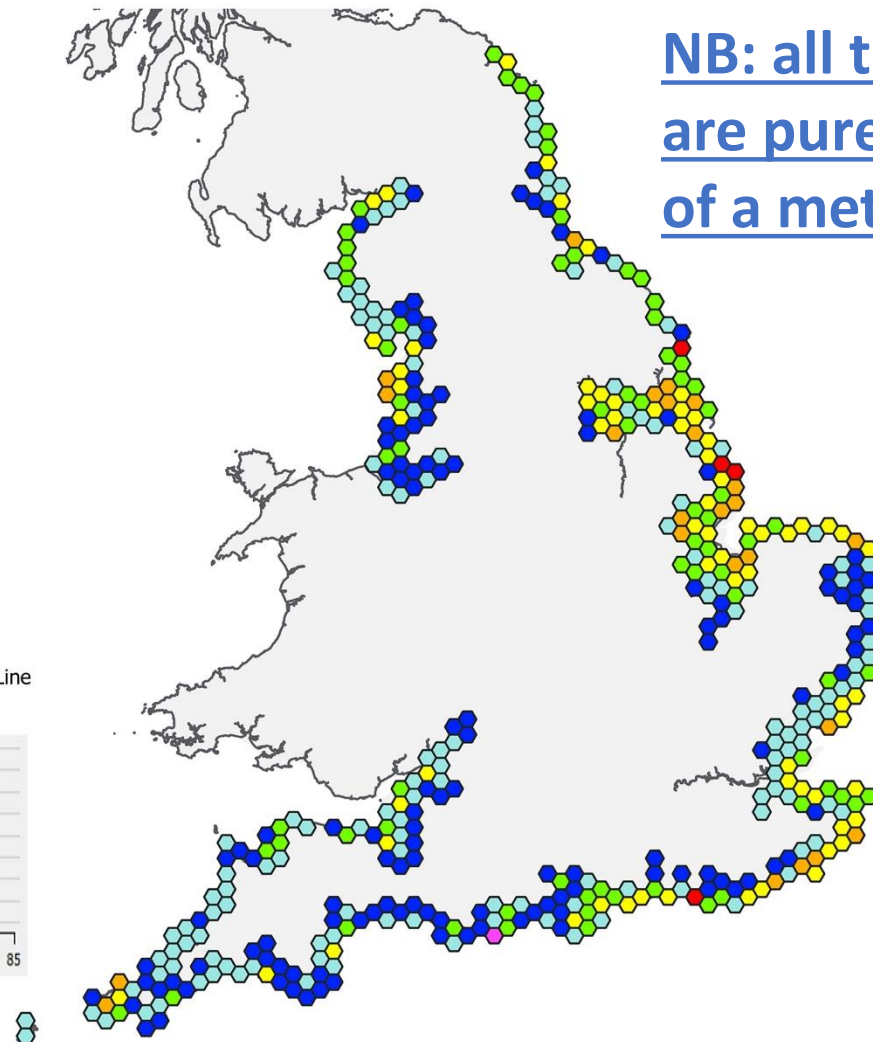
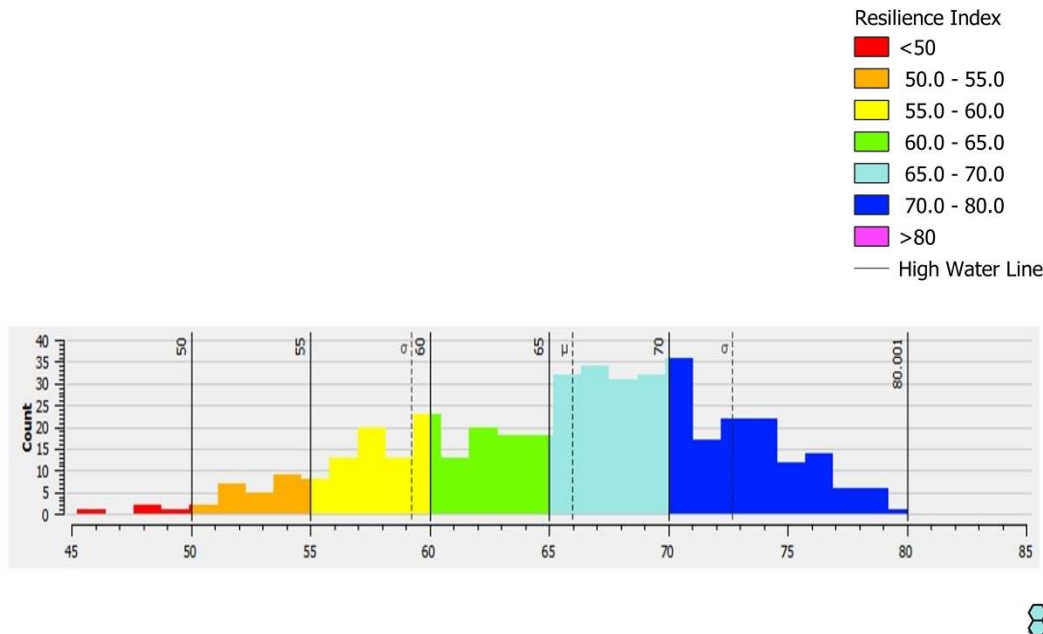
Social



# National application of CRM, showing variation in coastal system resilience in 90 km<sup>2</sup> hexagonal units

This combined RI – averages the economic, social and environmental perspectives

NB: all these results are purely illustrative of a method!





# Summary

- We have developed a model that quantifies resilience to support an overarching goal of enhancing coastal resilience to flooding and erosion.
- Economic, environmental and social dimensions of resilience are quantified using open-access geospatial datasets in conjunction with Multiple-Criteria Analysis.
- Subjective MCA weightings are used constructively to express stakeholder perspectives.
- Our analysis expands current risk-based shoreline management planning to a broader perspective that takes greater account of coastal community characteristics and priorities.
- Given suitable hazard and socio-economic scenarios, modelled resilience time trajectories reveal the impact of alternative adaptive pathways.
- A transition to resilience-based management challenges existing governance arrangements.
- But this approach provides a robust evidence-based framework for delivering sustainable, equitable and societally acceptable adaptive responses to climate change at the coast.



# Paper in review and web site reports

## Operationalising Coastal Resilience to Flood and Erosion Hazard: A Demonstration for England

By I.H. Townend<sup>1</sup>, J.R. French<sup>2</sup>, R.J. Nicholls<sup>3</sup>, S. Brown<sup>4</sup>, S. Carpenter<sup>5</sup>, I.D. Haigh<sup>6</sup>, C.T. Hill<sup>7</sup>, E. Lazarus<sup>8</sup>, E.C. Penning-Rowsell<sup>9</sup>, C.E.L. Thompson<sup>10</sup> and E.L. Tompkins<sup>11</sup>

Will be available on <https://www.channelcoast.org/ccoresources/coastalres/> together with other relevant reports and papers.

As material becomes available we will inform attendees of this webinar that they are available.





# Acknowledgements

This work was supported by the SPF UK Climate Resilience Programme through UK Research & Innovation award NE/S016651/1.

The East Solent Coastal Partnership and the Scarborough District Council hosted our regional workshops. We thank all the participants at our national and regional workshops.

Susan Hanson helped prepare the figures presented here.





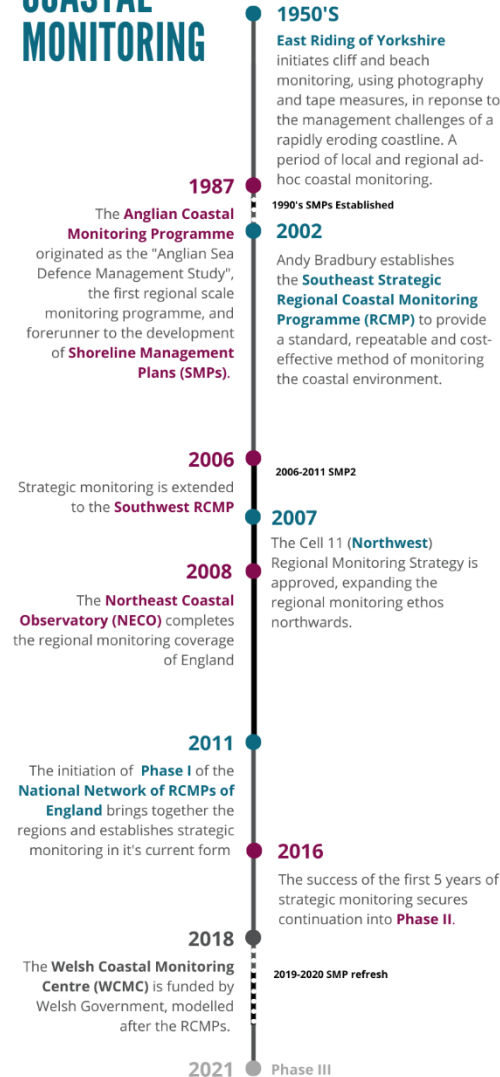
Charlotte Thompson  
Director  
Channel Coastal Observatory



# The National Network of Regional Coastal Monitoring Programmes of England

## A BRIEF HISTORY OF STRATEGIC COASTAL MONITORING

The National Network of Regional Coastal Monitoring Programmes provides strategic monitoring to support FCERM. This is a brief history of the programme.



## What is NNRCMP?

A long-running, strategic, risk-based monitoring network.

It provides targeted, informed, standardised, efficient and openly available data of coastal change.

## Aim

To provide the *appropriate evidence* on which robust and efficient FCERM decision, responses and investment can be based.

## The Coastal Resilience Project

Stakeholders and End Users

Spatial Data collectors and providers

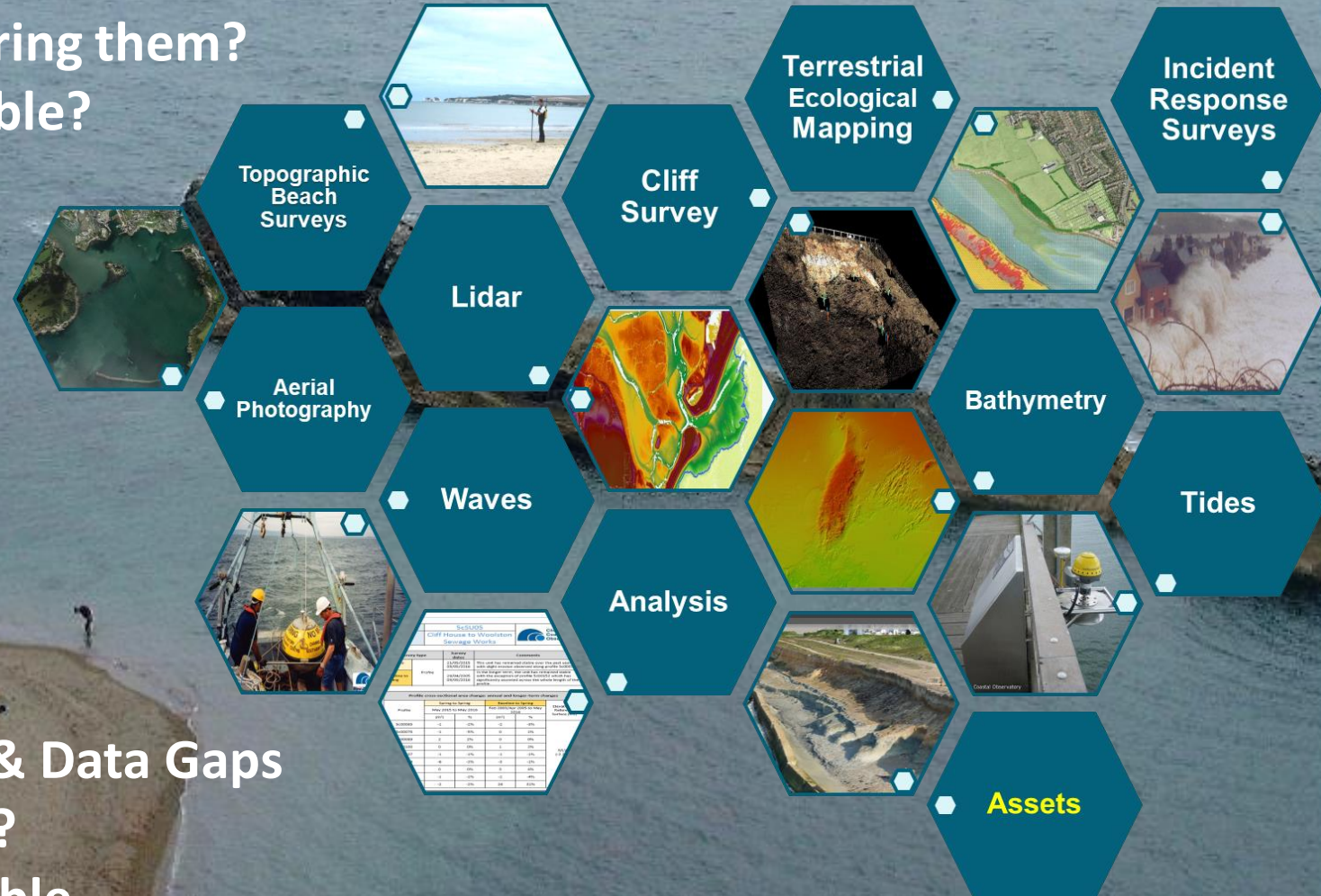
[www.coastalmonitoring.org](http://www.coastalmonitoring.org)





# Quantification of Resilience

What metrics do we need?  
Are we monitoring them?  
Are they available?



## Evidence Base & Data Gaps

- Does it exist?
- Freely available
- Easily accessible/useable
- New evidence needs and different target end users



# A Broader Perspective

Beyond the coastal engineer.....

- Cross-department
- Cross-institution
- Partnership Working

Strategic

- Investment, commitment & a clear definition.....
- Geospatial Commission
- Shoreline Management Plan Refresh

What is resilience?