Coastal flooding risk on the Somerset coastline and management responses

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Lecture :

- Introduction to the location and environment
- History of flooding in the region
- Vulnerability to flooding and current protection
- Future problems
- Coastal management responses

The roles of the coast :

- Defence
- Habitat
- Resource

Introduction to the location and environment

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Introduction to the location and environment – coastal geomorphology

What are the key coastal influences in this area?

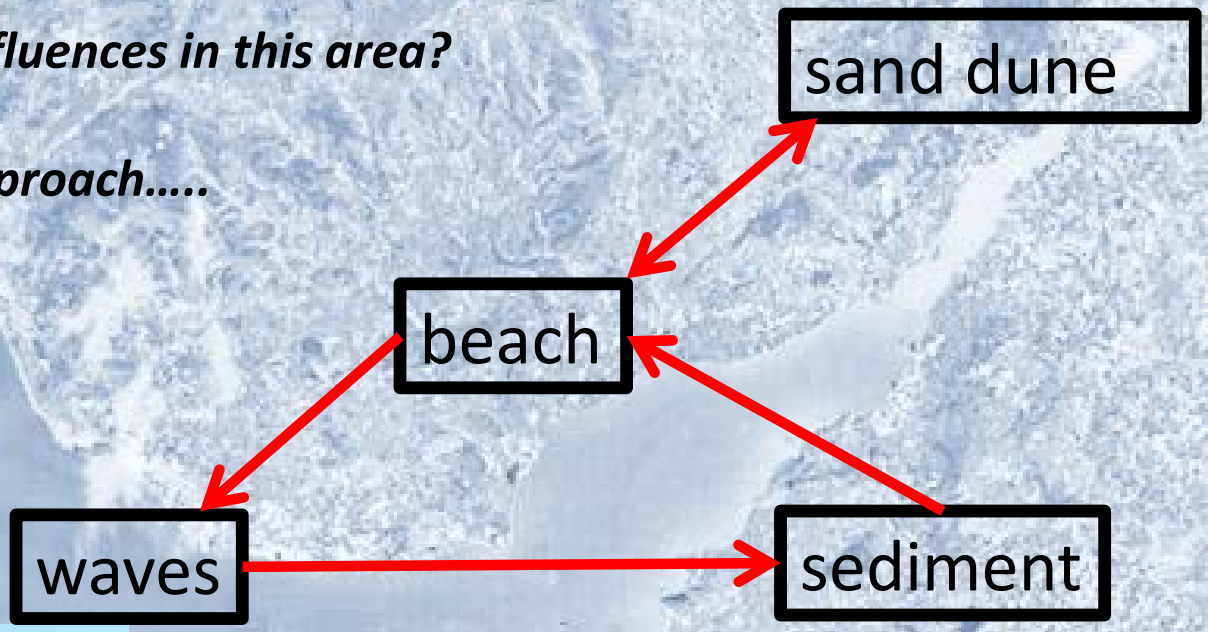
Remember your systems approach…..

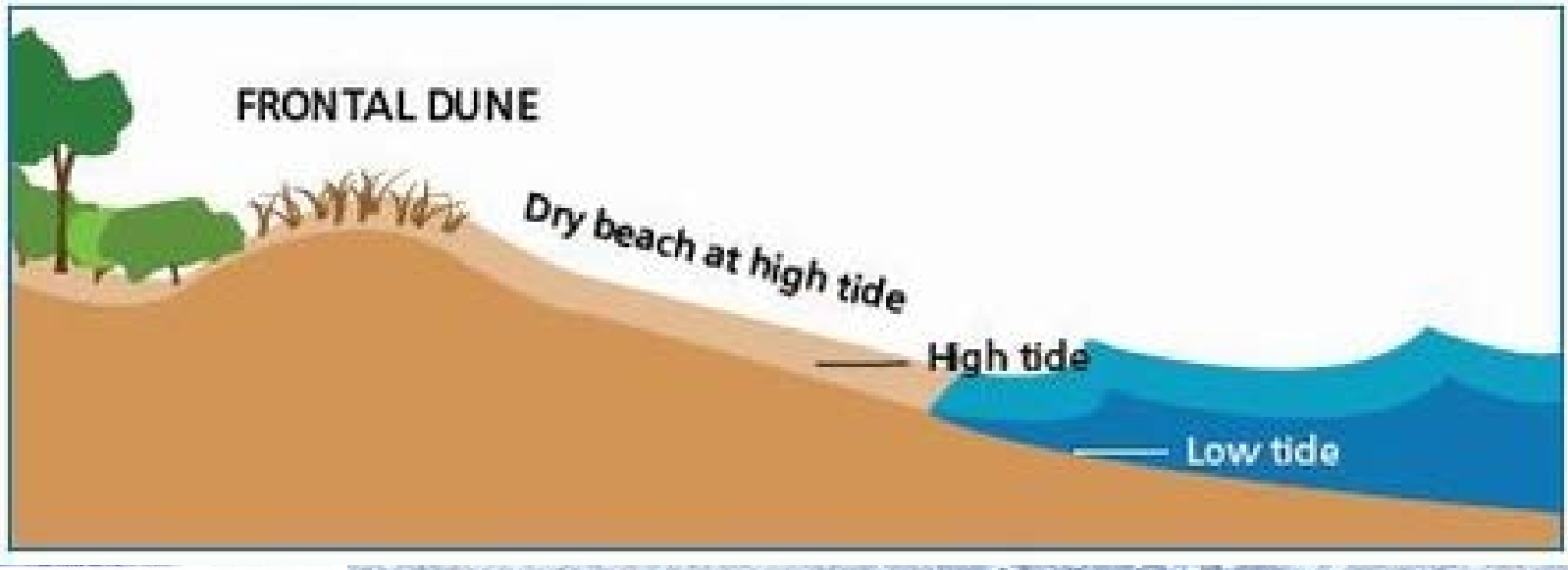
Waves	Tides
Wind	River
Storms	Sea level
Sediment supply	Vegetation
Geology	Beaches
Dunes	Saltmarshes
Mudflats	

Introduction to the location and environment – coastal geomorphology

What are the key coastal influences in this area?

Remember your systems approach…..





Introduction to the location and environment – coastal geomorphology

What are the key coastal influences in this area?

Remember your systems approach…..

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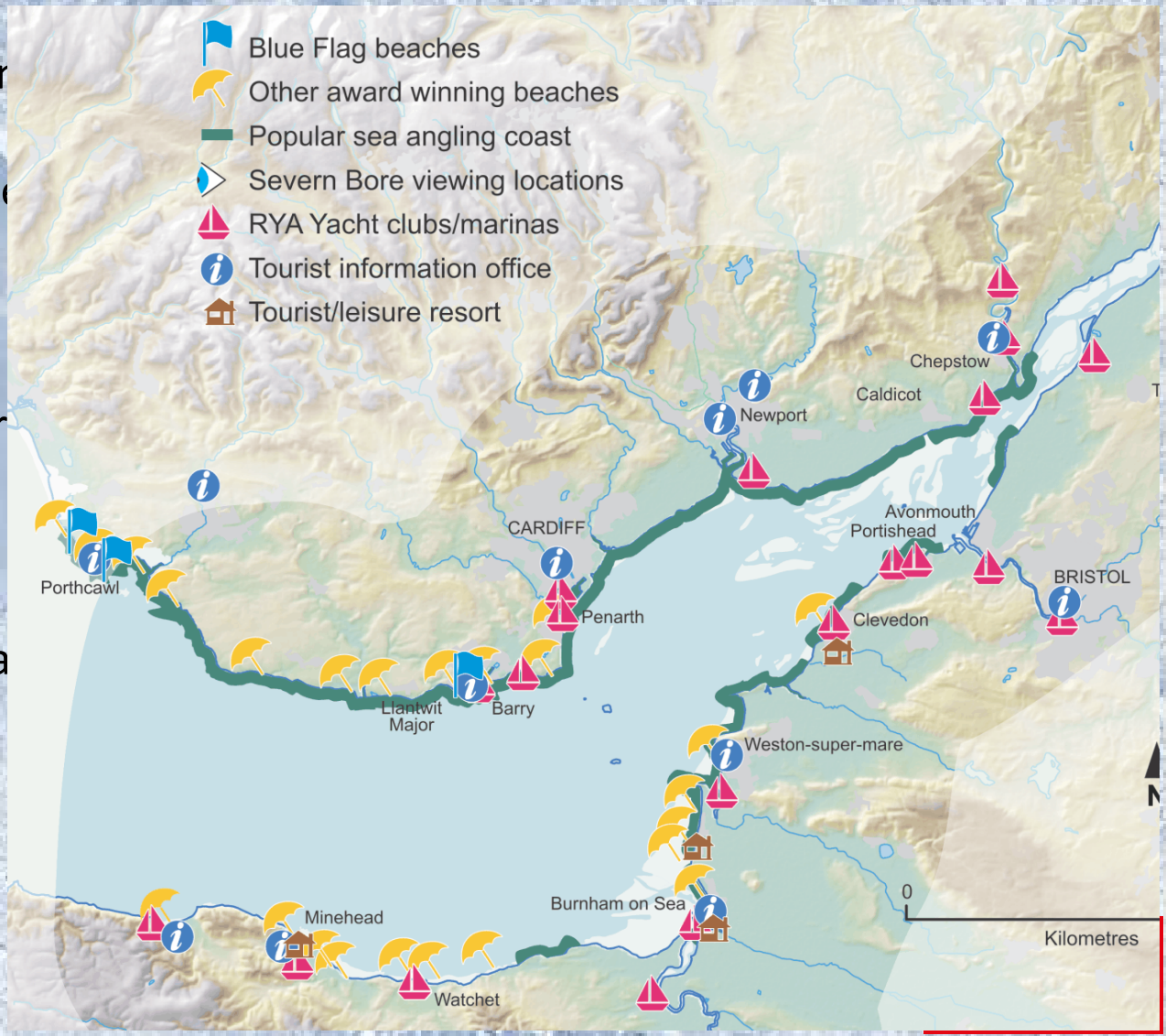
Introduction to the location and environment – human environment

What are the characteristics of the human environment in this area?

Residential	(Weston
Agriculture	Somerset
Industry	Various
Energy	Nuclear
Tourism	Various
Transport	M5 / Ra



A History of Flooding in Somerset?

There is a long history of flooding along the Somerset coast

13th December 1981

11km of coastal defences overtopped / damaged

Flood water reached M5

Cooling pump at Hinkley power station affected

1000 properties flooded

50km^2 agricultural land inundated

2500 cows/pigs/sheep killed

~£25M damage

A History of Flooding in Somerset?

There is a long history of flooding along the Somerset coast

<u>30th January 1607</u>

~2000 people drowned

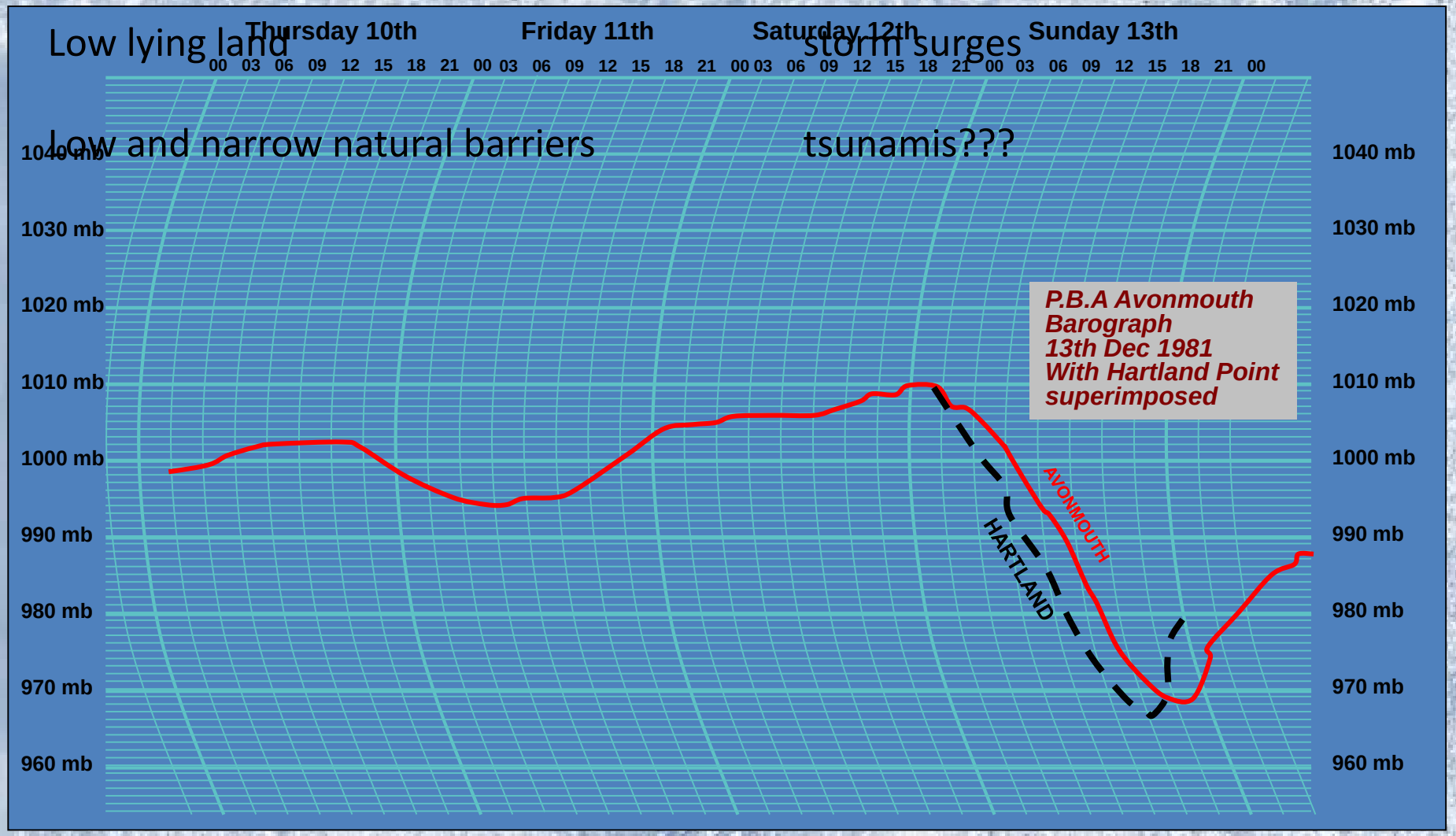
520km^2 land flooded

Water depths of greater than 3m

A simulation on the map (below), showing the probable extent of the flooding in 1607:

Vulnerability to flooding

What makes this coastline so vulnerable to flooding?



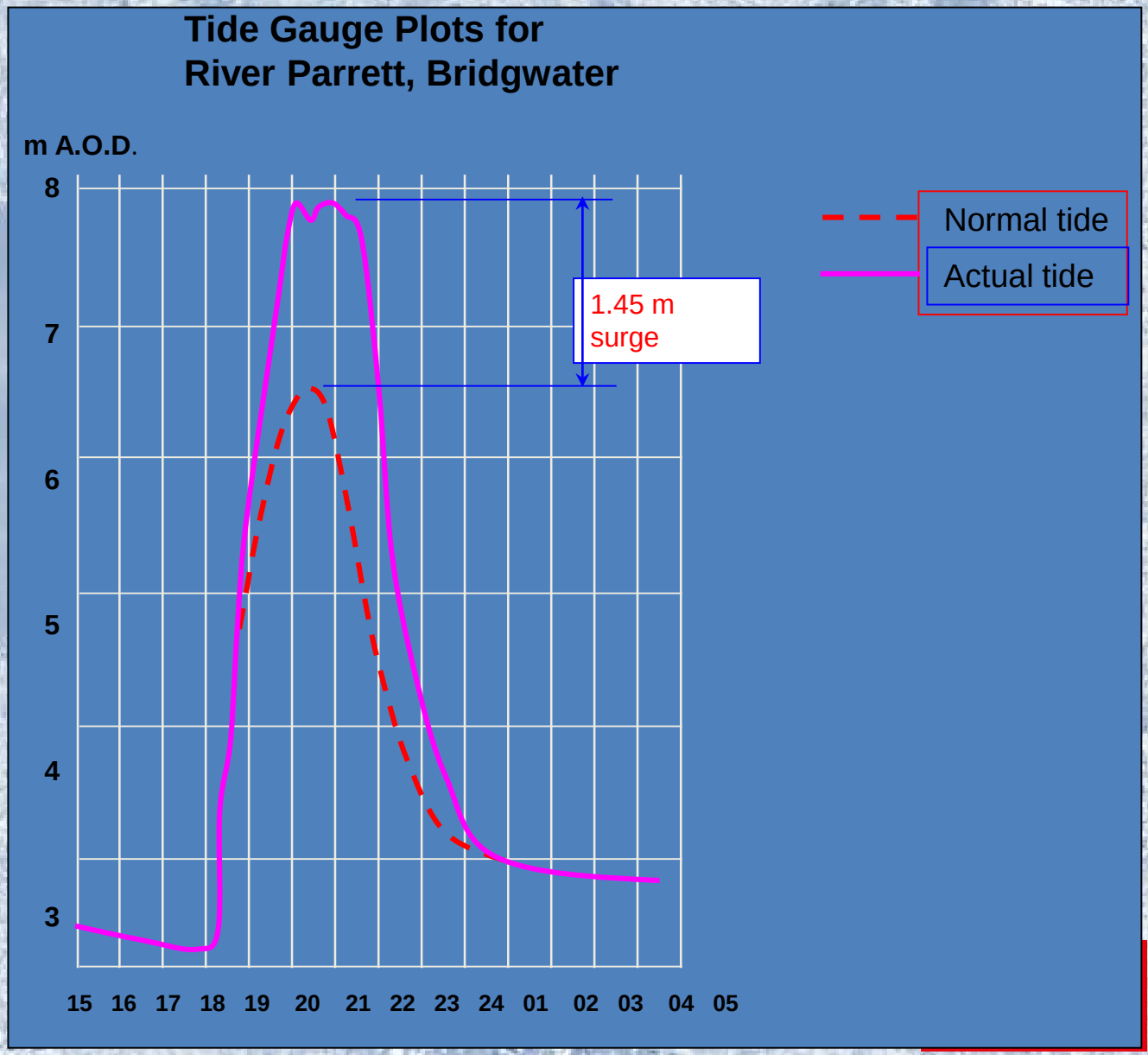
Vulnerability to flooding

Storm surge

- onshore winds
- increased runoff
- low pressure

- raised predicted tide level 1.45m

- Elsewhere in the area it was raised by 2m



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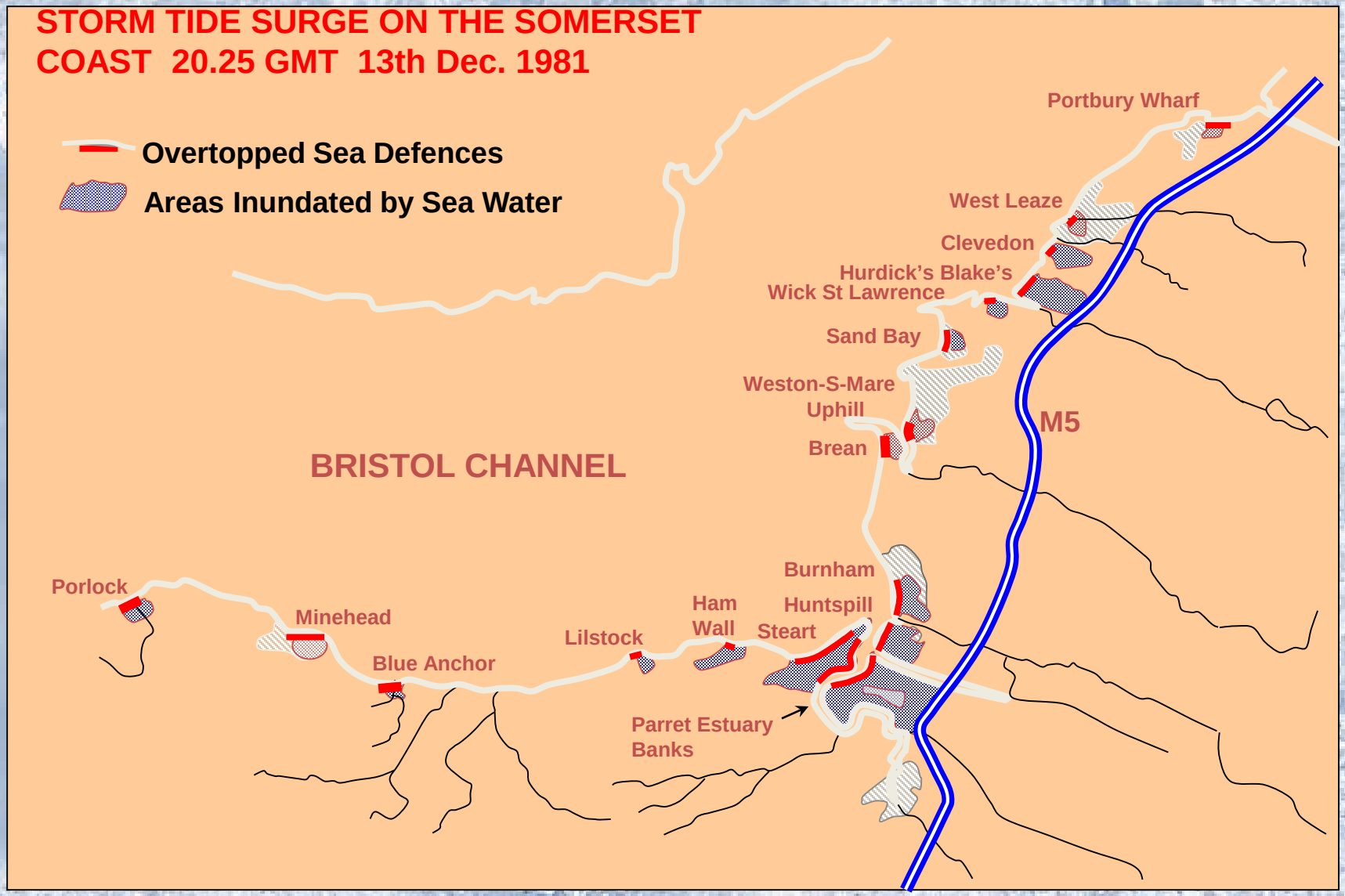
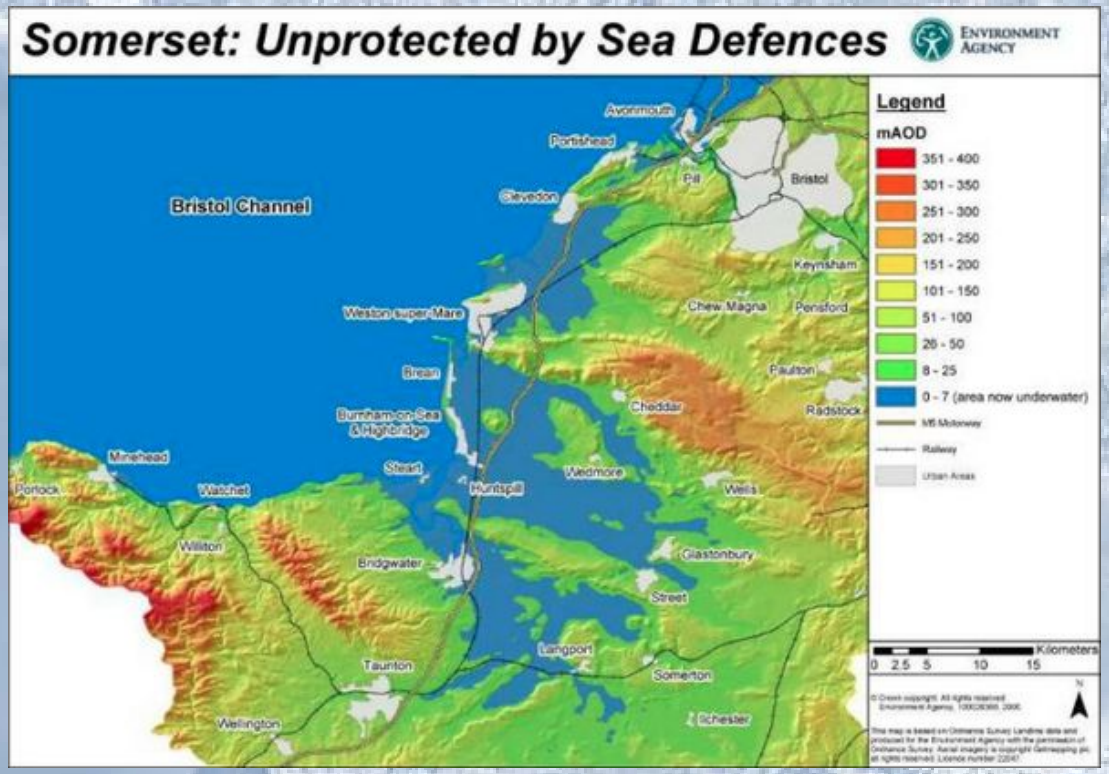
Vulnerability to flooding



Vulnerability to flooding

Just how close to flooding is this coastline?



Completely reliant on the very narrow coastline?

Current defences

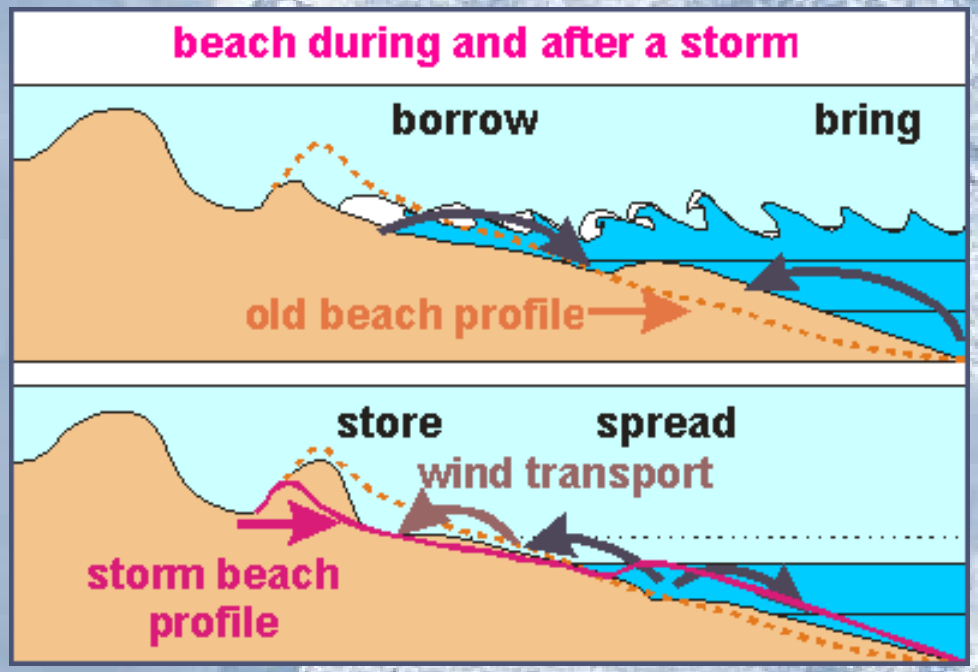
Coastal defence is currently provided by a combination of natural and man-made features

- Beaches and dunes
- Mudflats and saltmarshes
- Engineered defences

…..the 3 roles of the coast??

Current defences

The beaches and dunes absorb and dissipate wave energy by changing shape in response to high energy events.



sand dune

beach

This is a very delicate balance

waves

sediment

Future problems….

What future coastal problems can you foresee?

Sea-level rise

Coastal squeeze

Increased storminess

Sediment starvation

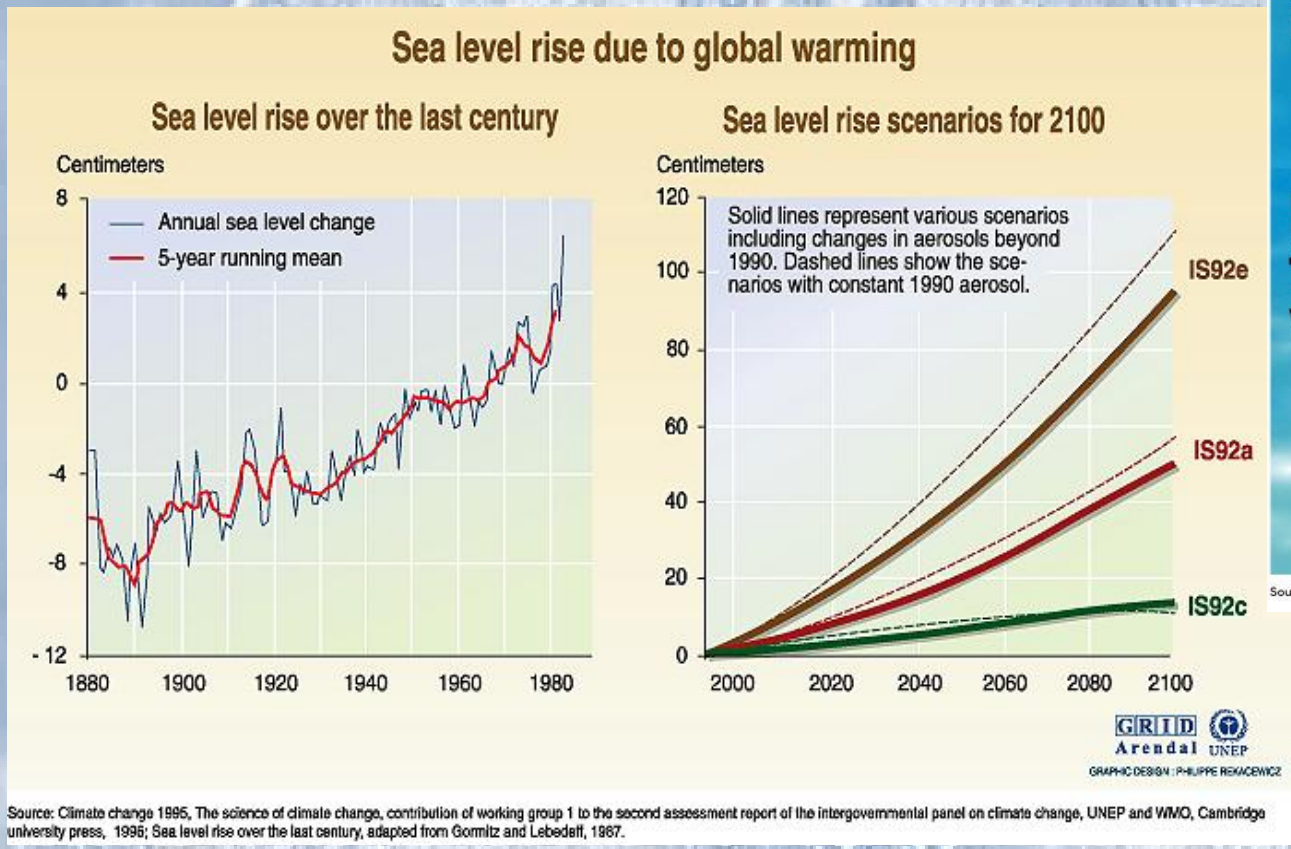
Sand dune erosion

Compacted beaches

Future problems….sea level rise

Future global warming

Accelerated sea level rise



Source: Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996; Sea level rise over the last century, adapted from Gornitz and Lebedeff, 1987.

Source: Rietbroek et al., Revisiting the contemporary sea level budget on global and regional scales, PNAS

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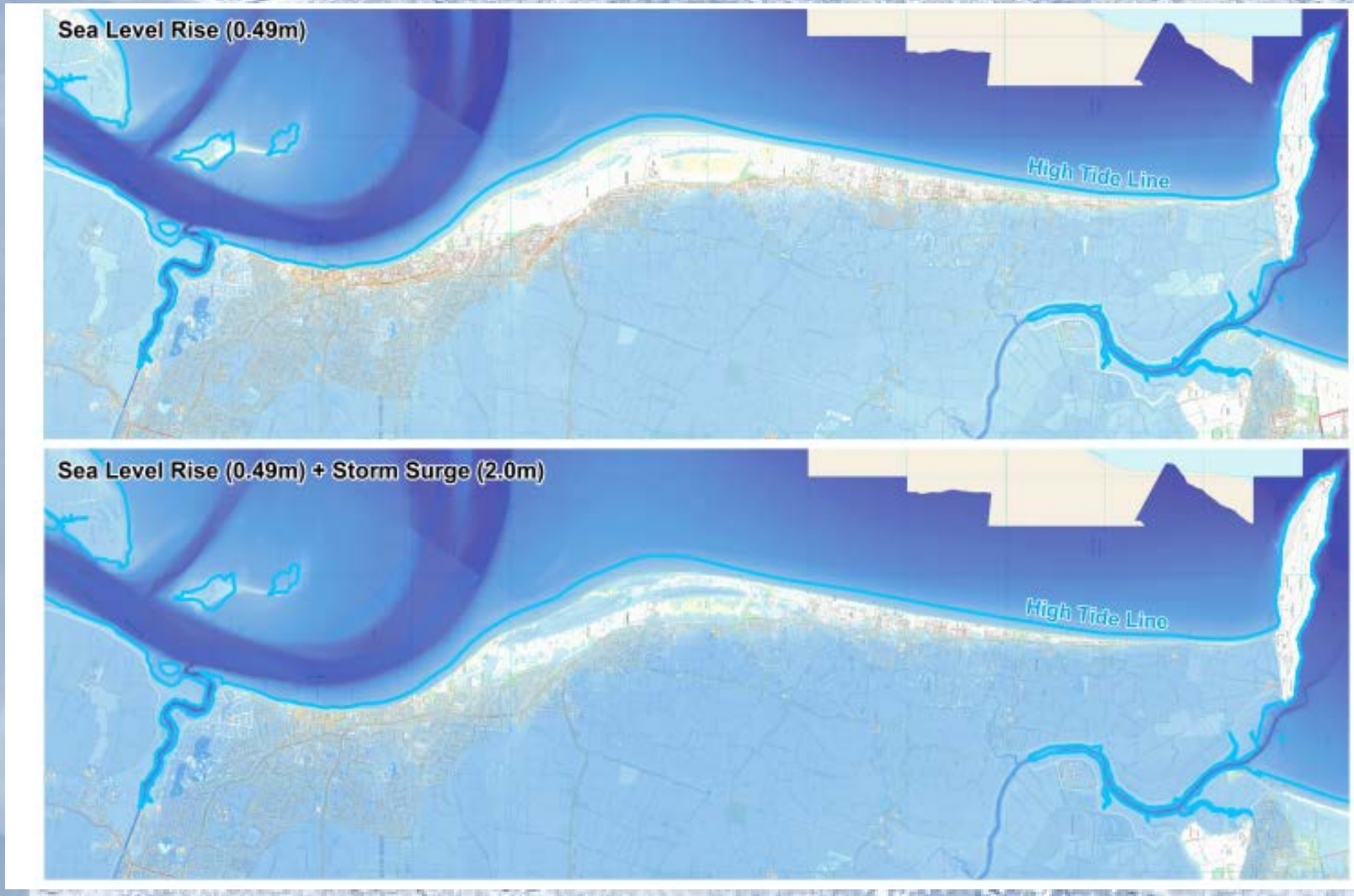
Future problems….sea level rise

Future global warming

Accelerated sea level rise



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Future problems….sea level rise

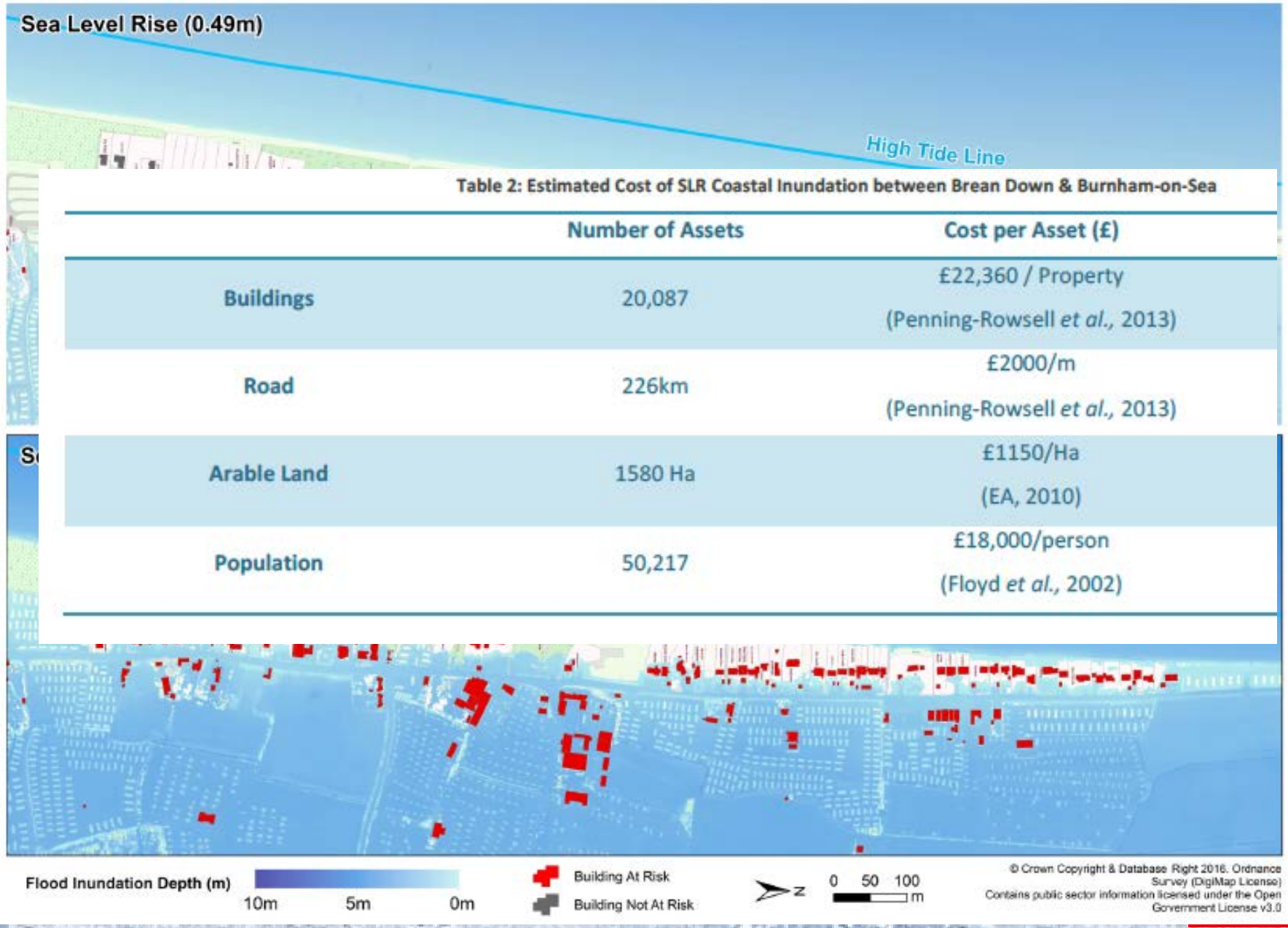

Table 2: Estimated Cost of SLR Coastal Inundation between Brean Down & Burnham-on-Sea

	Number of Assets	Cost per Asset (£)
Buildings	20,087	£22,360 / Property (Penning-Rowsell *et al.*, 2013)
Road	226km	£2000/m (Penning-Rowsell *et al.*, 2013)
Arable Land	1580 Ha	£1150/Ha (EA, 2010)
Population	50,217	£18,000/person (Floyd *et al.*, 2002)

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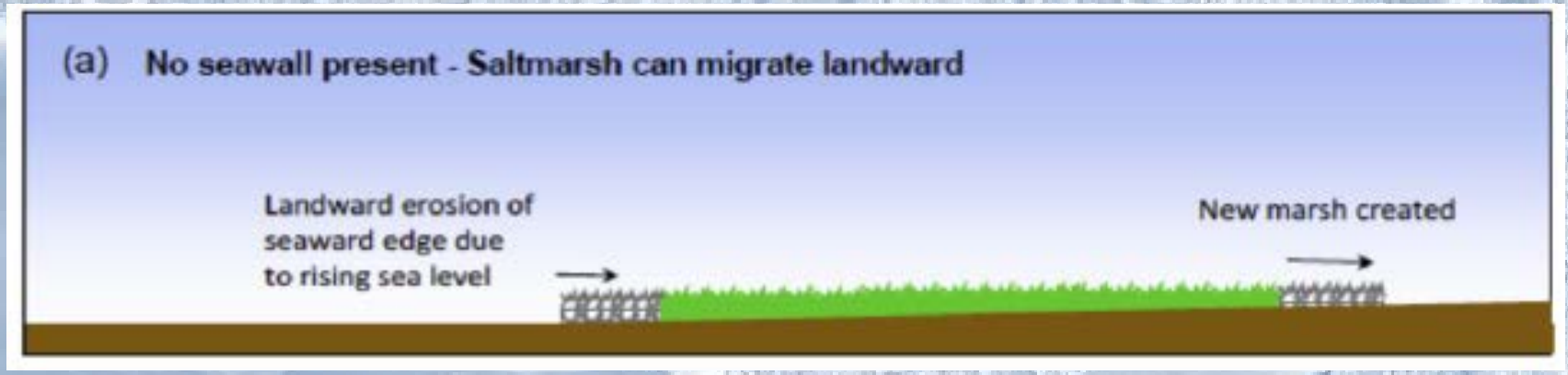
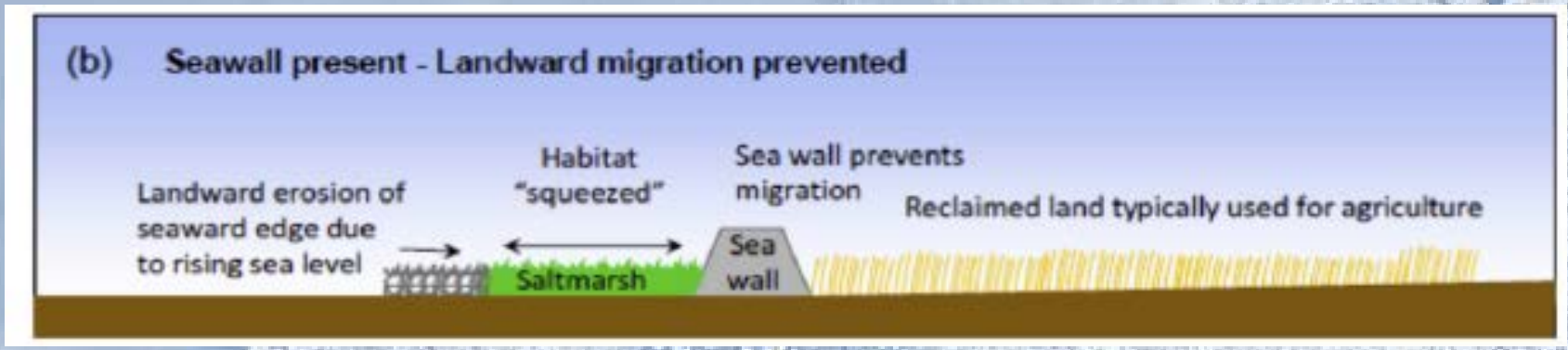
Future problems….coastal squeeze

Natural coastal landforms migrate inland to cope with sea level rise



Can happen if no development/defence exists but all of our coast has defence and development



Thus the protective natural defence is narrowing….

Future problems….increased storminess

Increased storminess

Increased sea surface temperatures

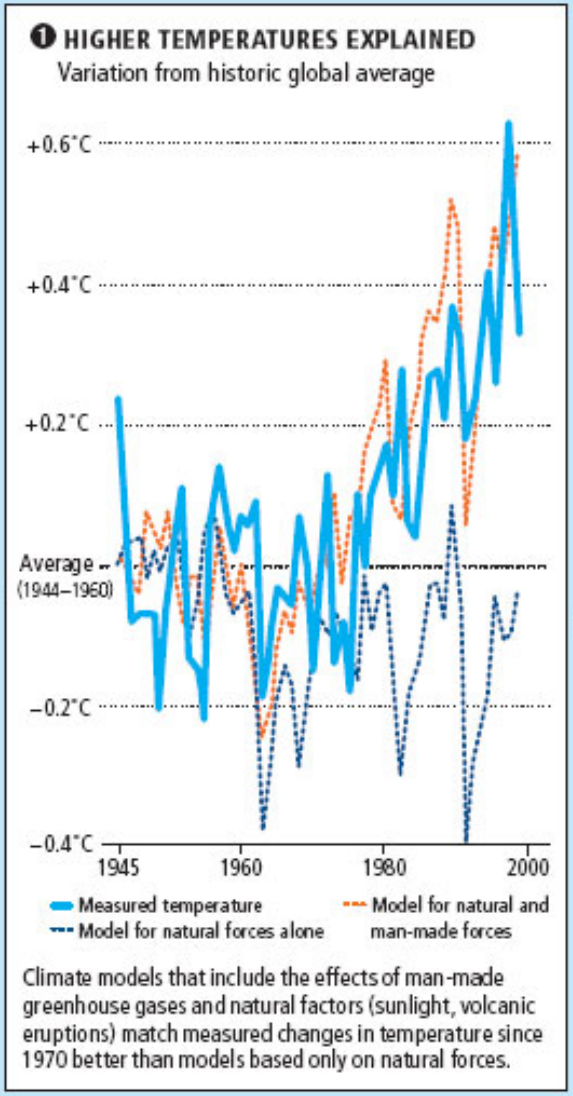
Increased power of storms

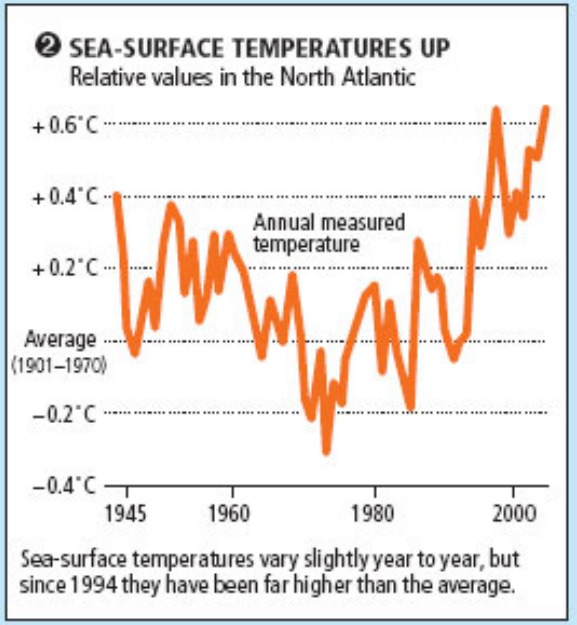
Deeper low pressure and increased winds

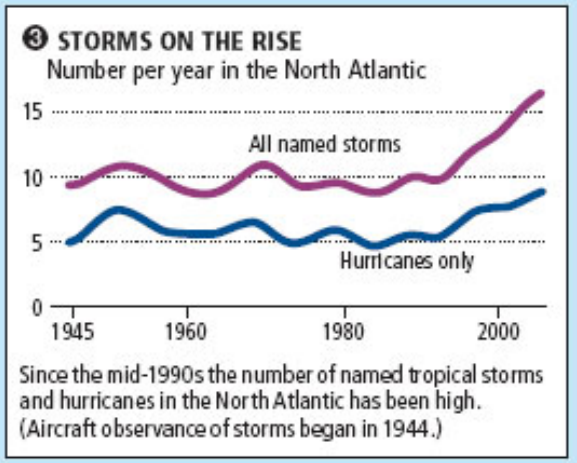
More powerful storm surges

Global Warming Exacerbates Storms

As human activities raise the earth's temperature ❶, sea-surface temperatures increase ❷, leading to more hurricanes in the North Atlantic ❸.







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Future problems….

Sediment starvation

The Severn Estuary is sand starved

Beaches are becoming more muddy

Wet sticky beaches

Impact on sand supply to the dunes?

Biological Journal of the Linnean Society (1994), *51*: 37–44. With 4 figures

The evolution of the fine sediment regime of the Severn Estuary and Bristol Channel

R. KIRBY

Geographical Association

Future problems….

Sediment starvation

Reduced sand deposition

Increased silt/clay deposition

Coastal system responding to changes

Sand Bay 1930

Bristol

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Future problems….Sand dune erosion

Defence relies upon narrow dune ridge

Coastal system…..??

Sand being lost from dunes

Ridge narrowing, protection reducing

Risk of flood increasing

Future problems….compacted beach

Defence relies upon narrow dune ridge

Dunes rely on sediment from the beach

Becoming more muddy

Compaction reduces sand transport

Ridge narrowing, protection reducing

Risk of flood increasing

Summary:

Important area – defence / habitat / resource

Vulnerable to flooding in the past

Risk of flooding will increase with climate change

The protective coastal barrier narrowing and will continue to do so

<u>What options exist to manage this situation?</u>

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Coastal management responses :

We will need some hard engineering

Few alternatives possible now

Land too valuable / too polluted

Good for defence/habitat/resource?

Coastal management responses :

Soft engineering solutions - beaches

Our systems approach to understanding coasts helps here

Wave energy will increase

We need to reduce wave energy

Can build beaches higher

Can build offshore barriers

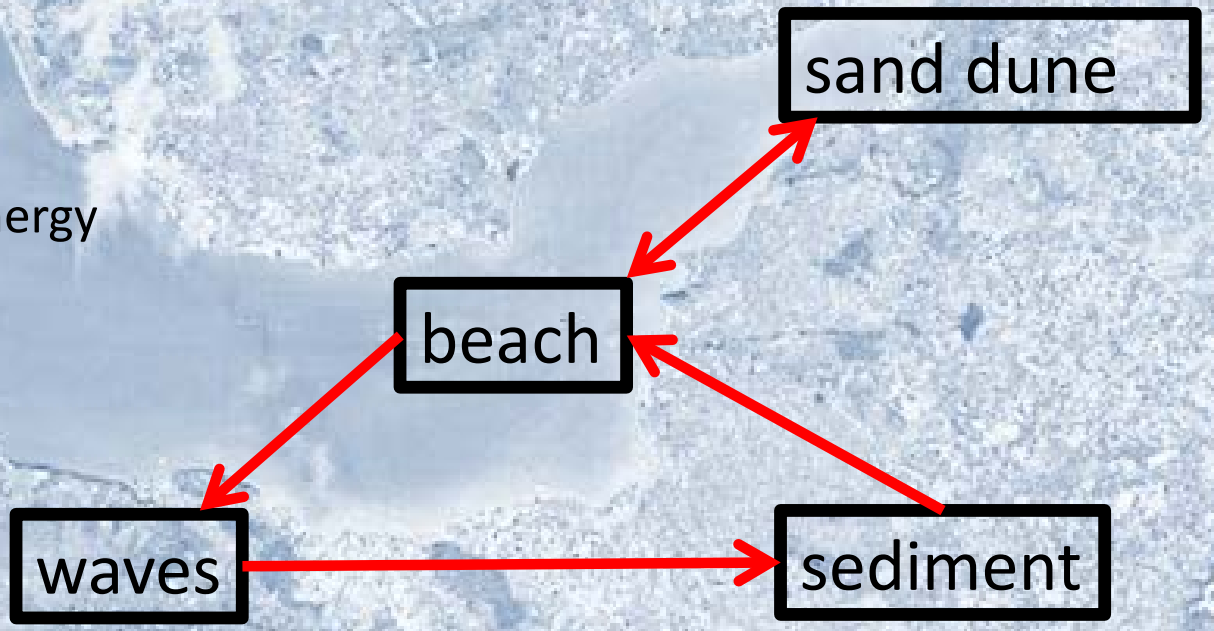

Figure 7 *– Offshore breakwaters along the Norfolk coast promoting sediment deposition. Sourced from Google images.*

Good for defence/habitat/resource?

Good for defence/habitat/resource?

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Good for defence/habitat/resource?

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Figure 1. Aerial photograph of the Sand Engine after completion (September 2011) looking southward. Picture courtesy of Rijkswaterstaat/Joop van Houdt.

Good for defence/habitat/resource?

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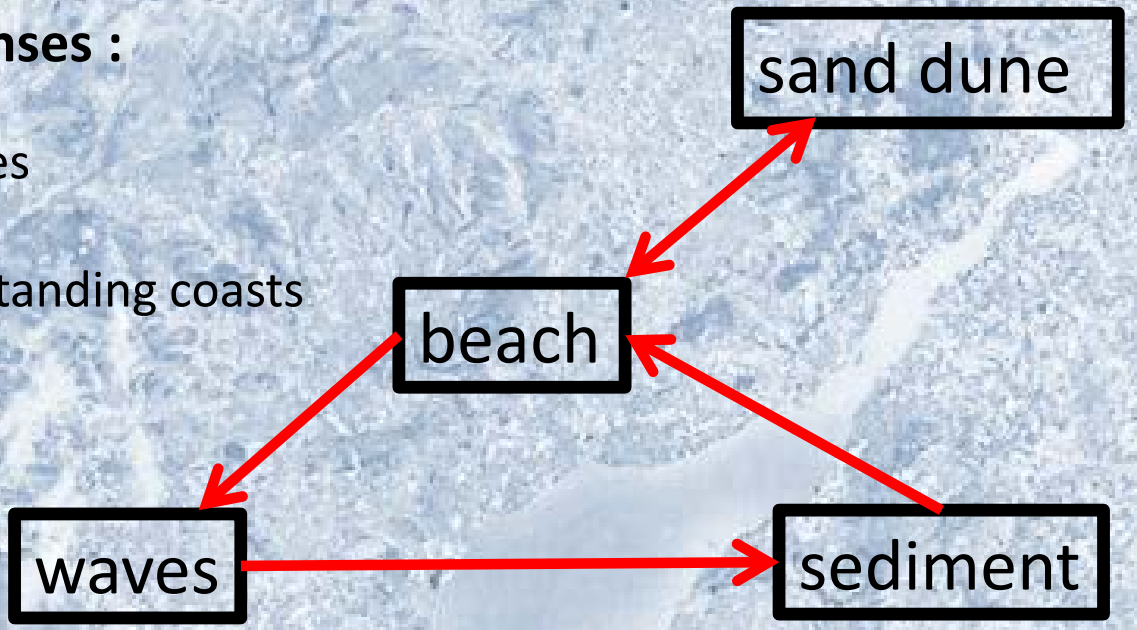
Coastal management responses :

Soft engineering solutions - dunes

Our systems approach to understanding coasts helps here too



Healthy beach – healthy dunes

Will increase sediment supply to the dunes

Manage footpath access

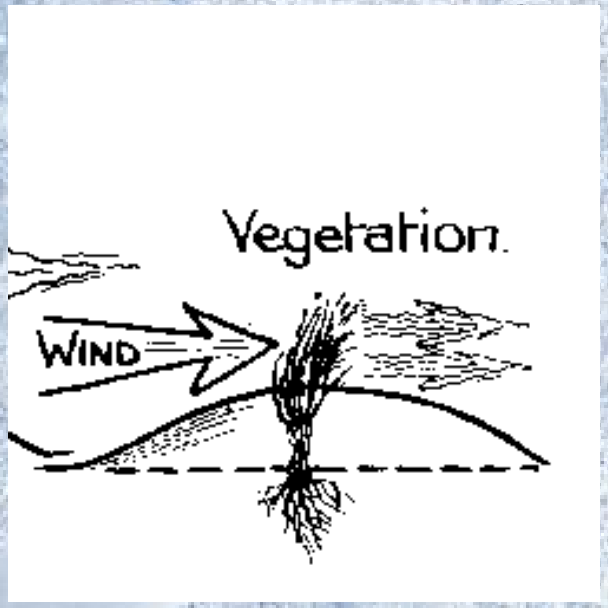
Restore ‘natural’ dune – maintain or increase the barrier protecting the low lying land

Work with the processes and a systems understanding of how dunes work

Restore dune vegetation
Manage tourist access

Repair eroded areas to maintain the natural barrier

Good for defence/habitat/resource?



Coastal management responses cost

Technique		
	Design and Permitting	Construction
Artificial Dunes & Dune Nourishment	Low	Low
Controlling Overland Runoff	Low	Low
Planting Vegetation	Low	Low
Bioengineering - Coir Rolls on Coastal Banks	Low-Medium	Medium-High
Bioengineering - Natural Fiber Blankets on Coastal Banks	Low	Low
Sand Fencing	Low	Low
Beach Nourishment	Medium	Low-Medium
Rock Revetments - Toe Protection	High	High
Rock Revetments - Full Height (up to predicted flood zone elevation)	Very High	Very High
Seawall	High-Very High	Very High

COST ESTIMATES *(average cost per linear foot of shoreline)*
Low: <$200
Medium: $200-500
High: >$500-1,000
Very High: >$1,000

http://www.mass.gov/eea/docs/czm/stormsmart/properties/cost-comparison-chart.pdf

Summary :

- The location is important locally and nationally in its human and physical environment
- The area has a history of flooding and is very vulnerable to high energy events
- This situation will worsen with climate change
- Some areas are already so developed that hard engineering approaches are the only solution
- Where possible we can use our systems approach to manage the coast to be resilient to future pressures
- Better able to provide defence / habitat / resource

Thank you….any questions?

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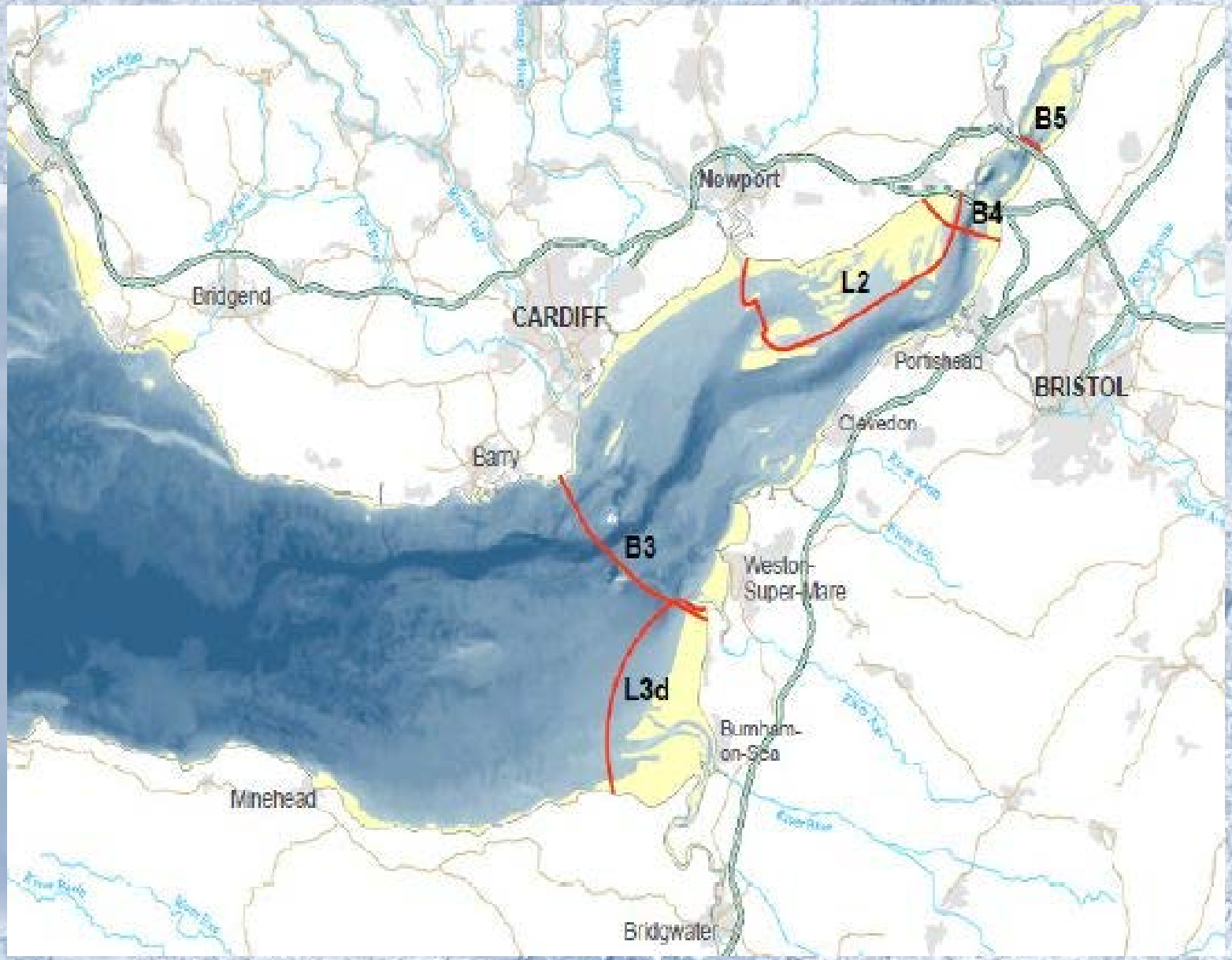
B5
Newport
B4
L2
Bridgend
CARDIFF
Portishead
BRISTOL
Clevedon
Barry
B3
Weston-
Super-Mare
L3d
Burnham-
on-Sea
Minehead
Bridgwater