Flood risk on the Somerset coast:

causes and effective management solutions

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UWE, Bristol

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Introduction:

- What is the coast?
- Introduction to the location
- A systems approach to understanding the coast
- History/causes of flooding
- Changes in risk of flooding
  - How will the coast respond?
- What level of risk is there?
- How might we manage
- Conclusions and resources

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What is the 'coast'?

Introduction to the location and environment

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Key characteristics of the area:

- extremely high tidal range
- exposed to prevailing winds / waves
- exposed to storms
- starved of sand
- low lying inland areas
- developed inland areas
- wide flat beaches/ dunes

What roles does the coast have?

Defence

What roles does the coast have?

Defence

Habitat

What roles does the coast have?

- Defence
- Habitat
- Resource

Coastal geomorphology

What are the key coastal influences in this area?

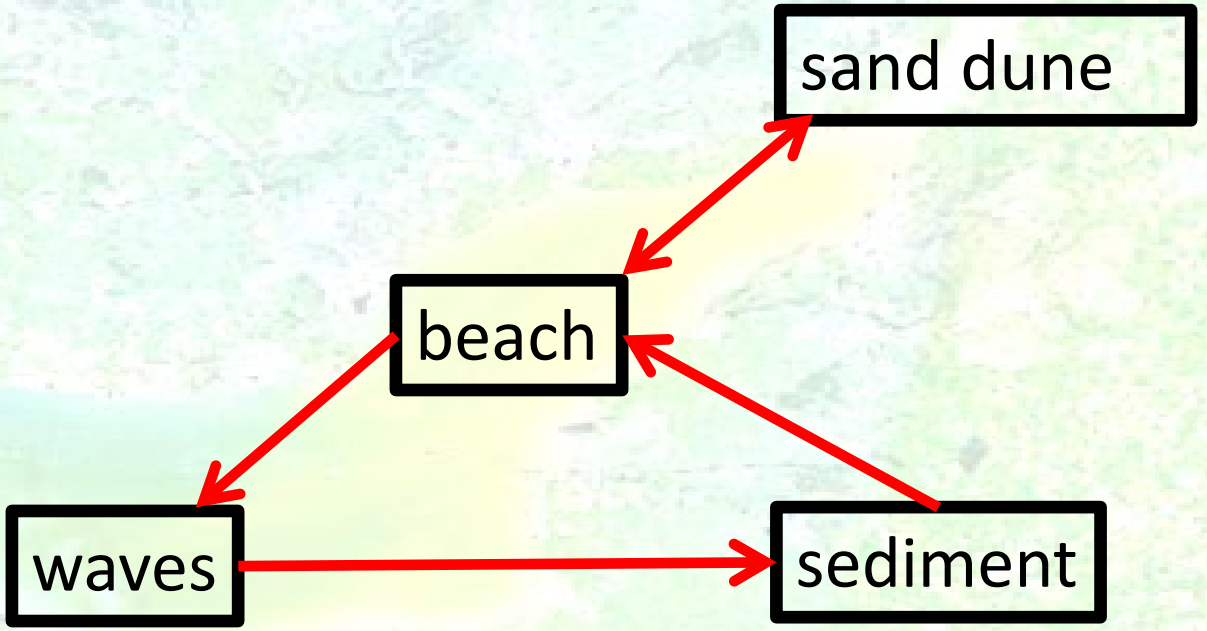
Use a systems approach…..

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

Coastal geomorphology

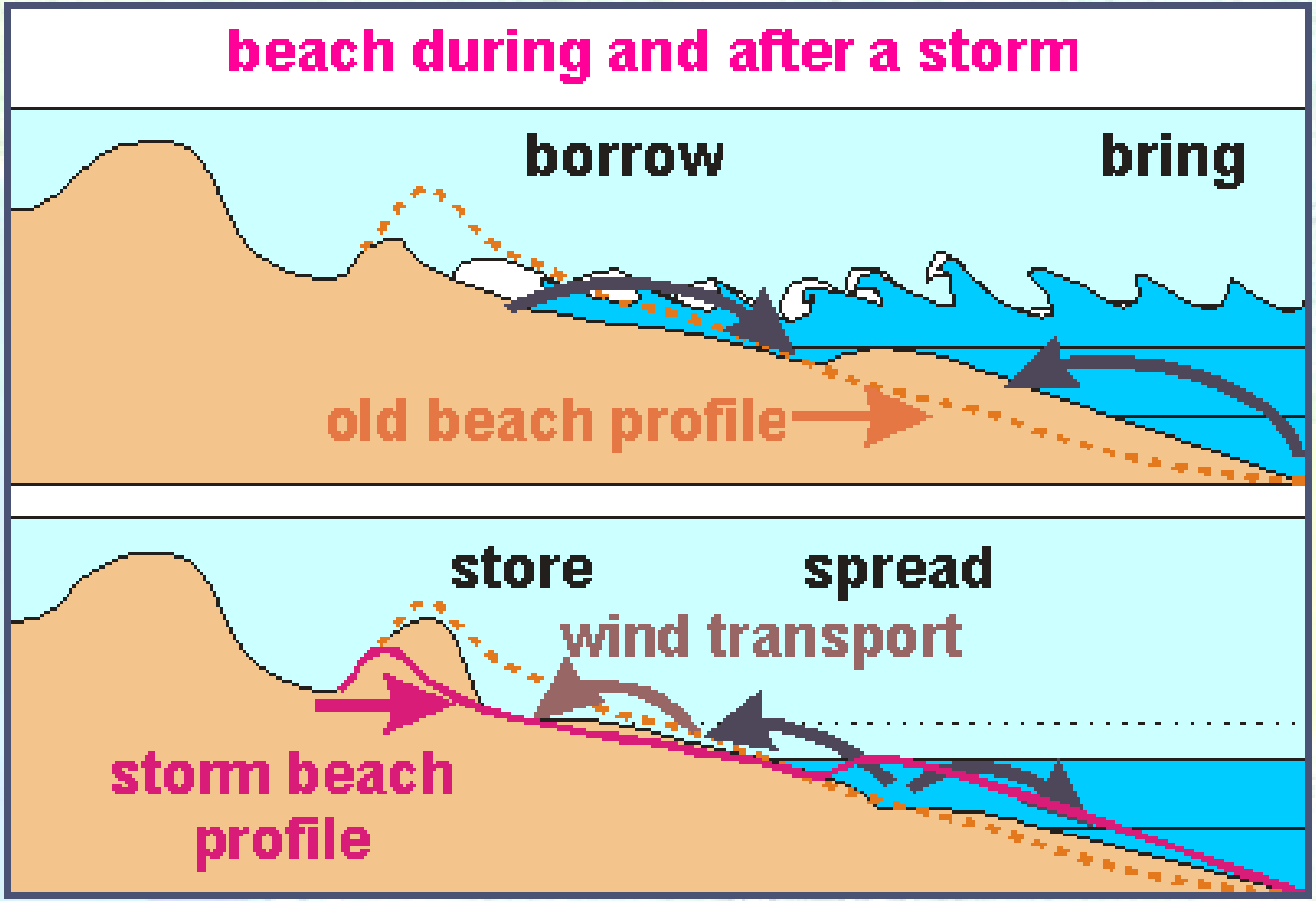
What are the key coastal influences in this area?

Use a systems approach…..



How does this cope with changes in energy such as storm/ calm?

beach during and after a storm



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There is a long history of flooding along the Somerset coast

30th January 1607

~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:

There is a long history of flooding along the Somerset coast

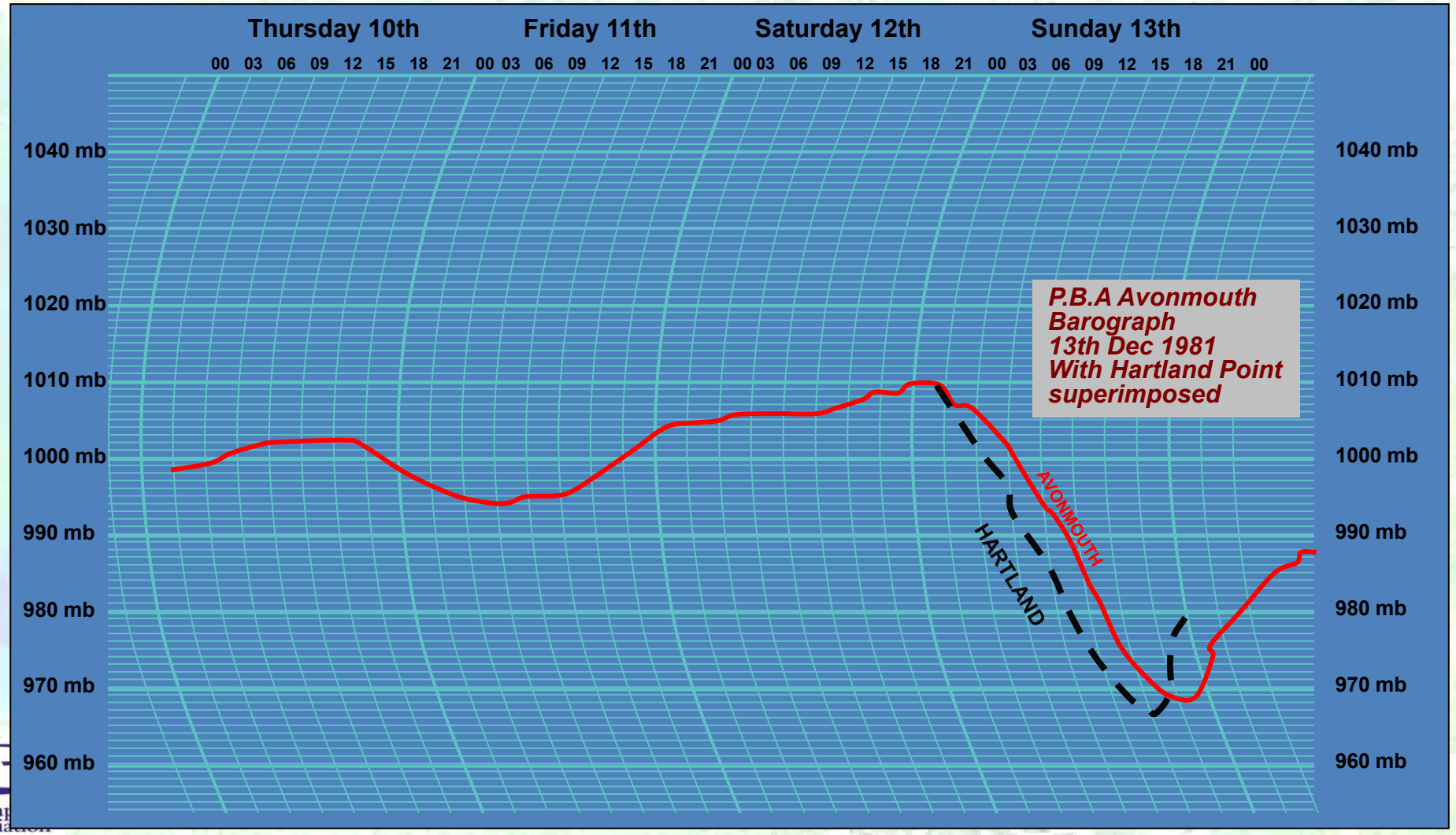
13th December 1981

11km coastal defences overtopped / damaged
Cooling pump at Hinkley power station affected
50km^2 agricultural land inundated
~£25M damage

Flood water reached M5
1000 properties flooded
2500 cows/pigs/sheep killed

What makes this coastline so vulnerable to flooding?

Low lying land storm surges tsunamis???



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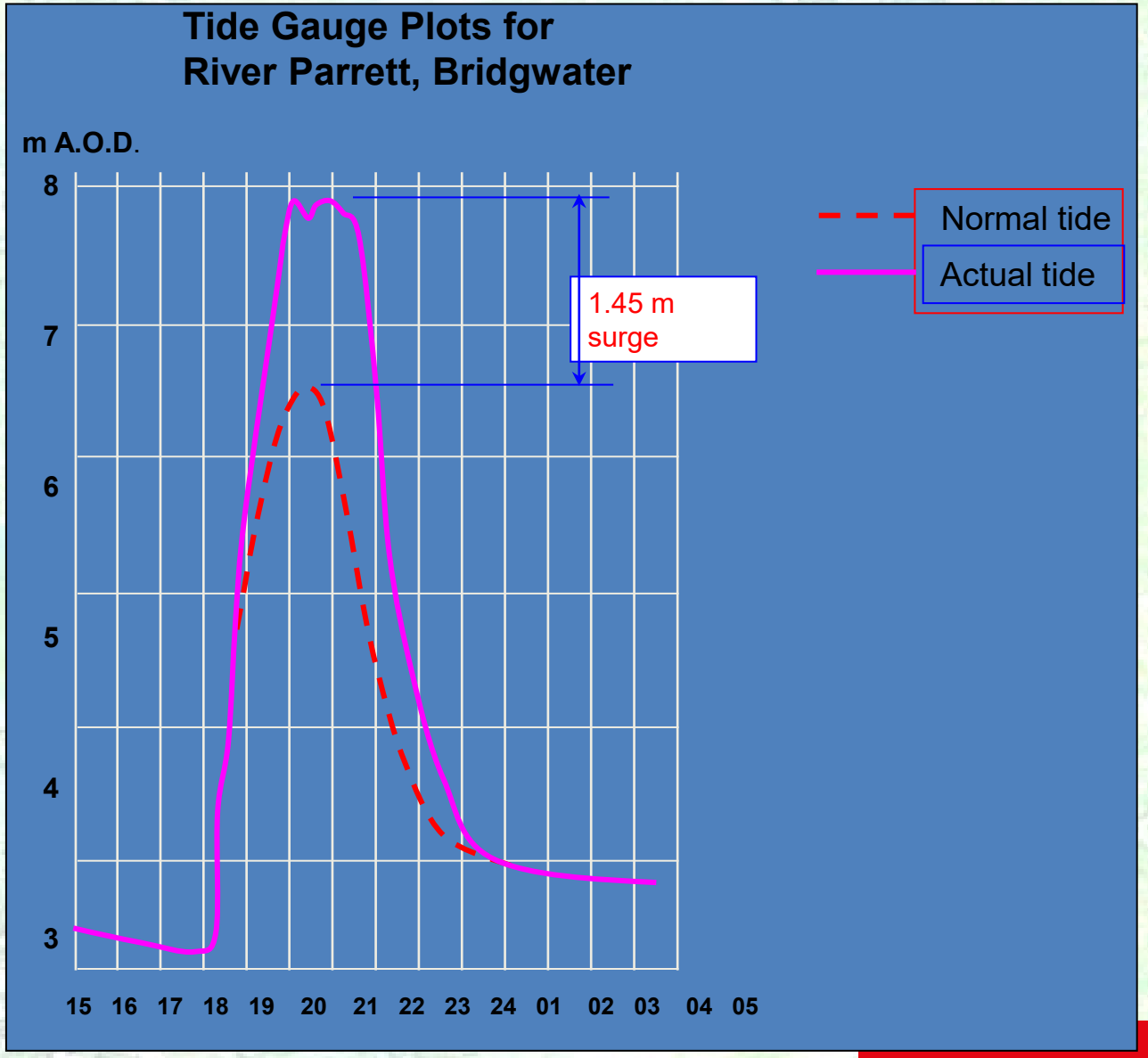
What makes this coastline so vulnerable to flooding?

Storm surge

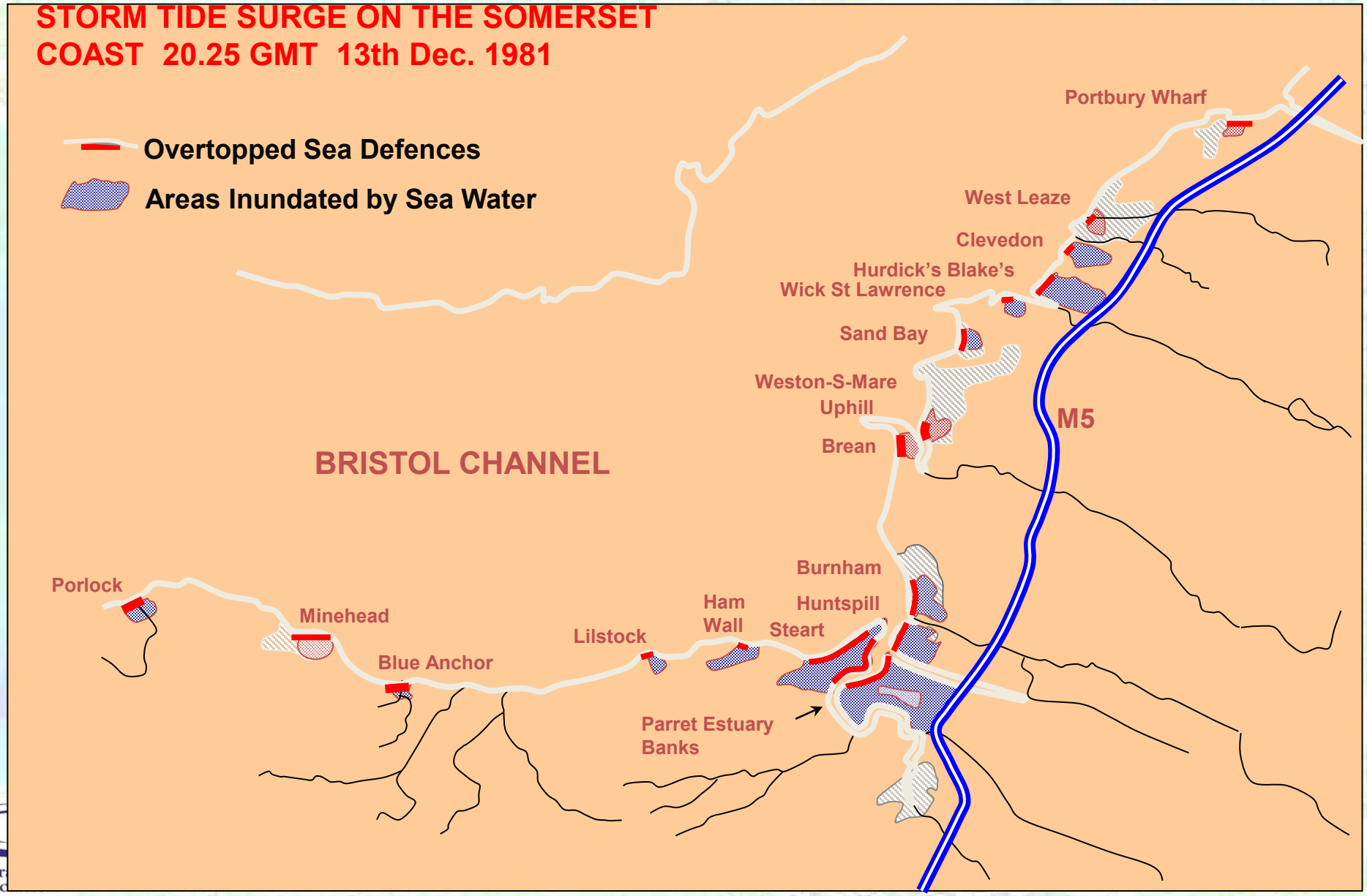
- onshore winds
- increased runoff
- low pressure

- raised predicted tide level 1.45m

- Elsewhere in the area it was raised by 2m



What makes this coastline so vulnerable to flooding?



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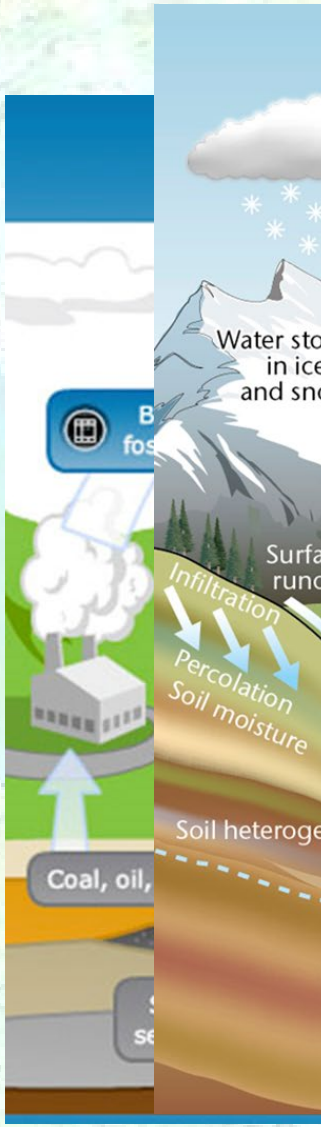
How will risks change in the future?

Large scale….

- changes in the carbon cycle
- changes in the water cycle
- changes in sea level
- changes in storm surges



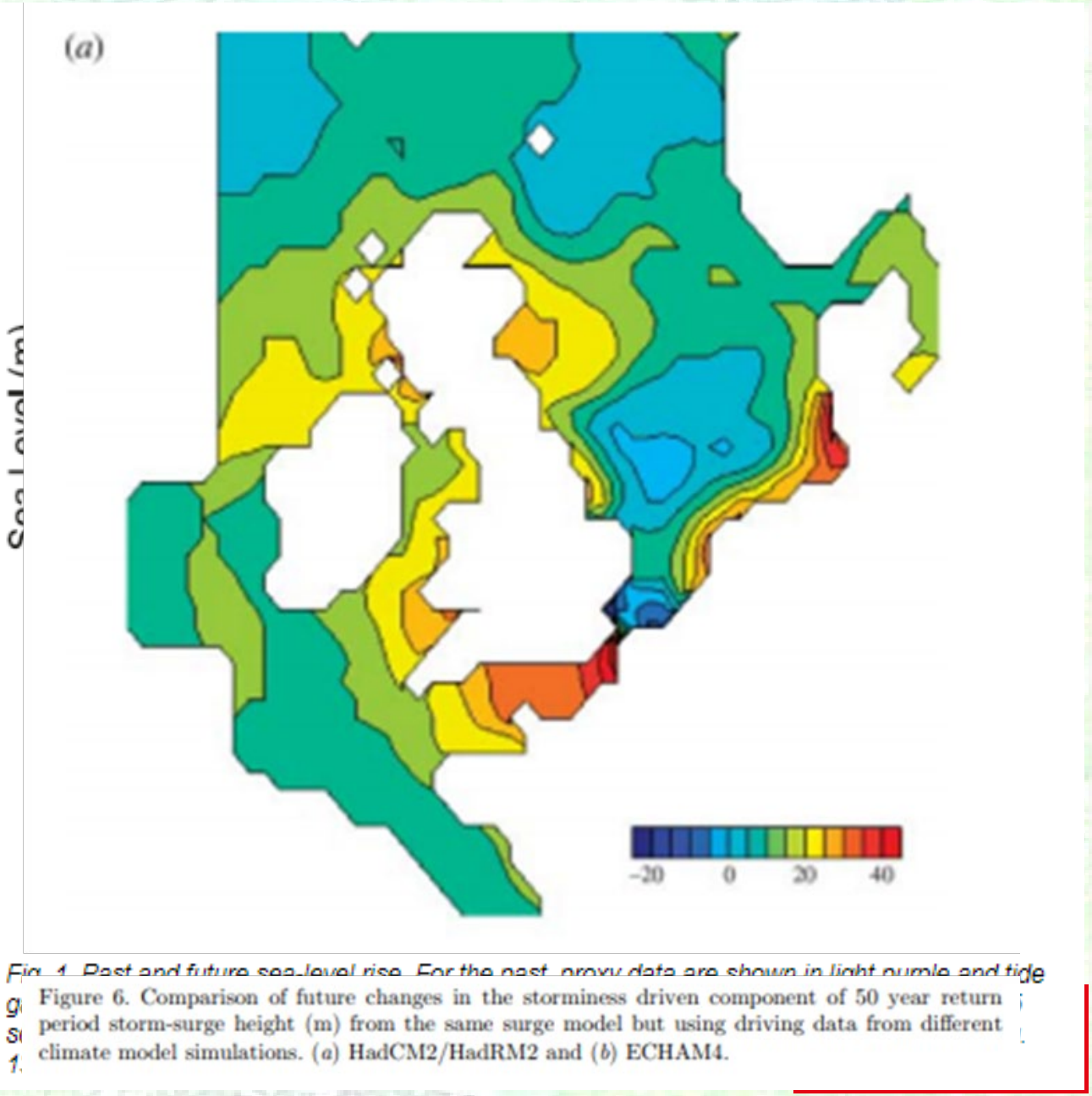


Figure 6. Comparison of future changes in the storminess driven component of 50 year return period storm-surge height (m) from the same surge model but using driving data from different climate model simulations. (*a*) HadCM2/HadRM2 and (*b*) ECHAM4.

How will risks change in the future?

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

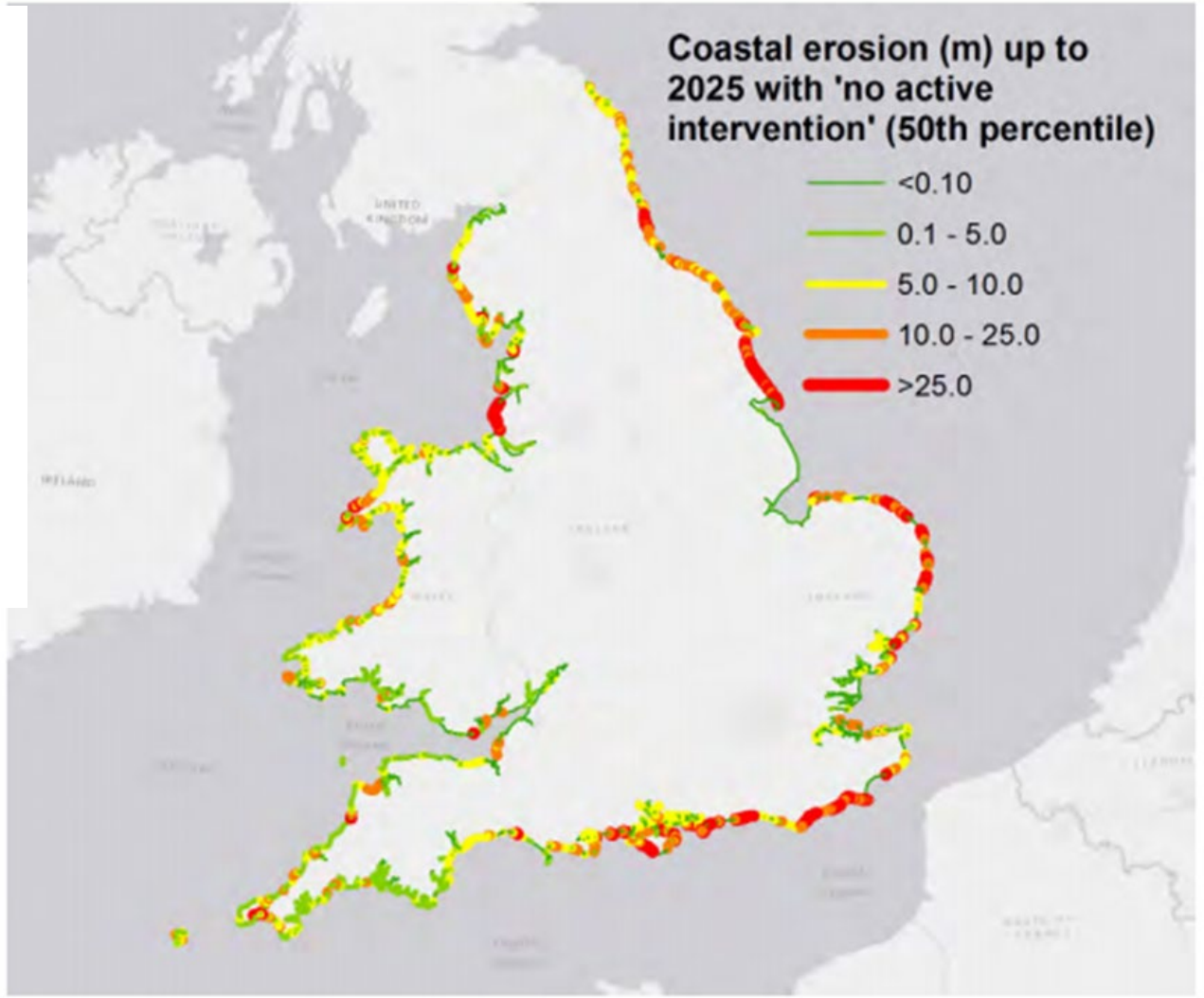
R. KIRBY

Ravensrodd Consultants Ltd., 6 Queens Drive, Taunton, Somerset TA14XW

committee on climate change (2018) stated existing government plans unaffordable to hold the coast and that we need to make some 'hard choices' would affect low lying areas such as the Somerset Levels.

https://www.theccc.org.uk/wp-content/uploads/2018/10/Managing-the-coast-in-a-changing-climate-October-2018.pdf

Figure 2.6. Data from the National Coastal Erosion Risk Map (NCERM) data for England and Wales showing the areas most susceptible to erosion. These data are for the 'mid-estimate' i.e. 50th percentile



Source: The NCERM data for the SMP coastlines presented here are acquired from the Environment Agency via the data.gov.uk portal and is subject to the following attribution: © Environment Agency copyright and/or database right 2016. All rights reserved.

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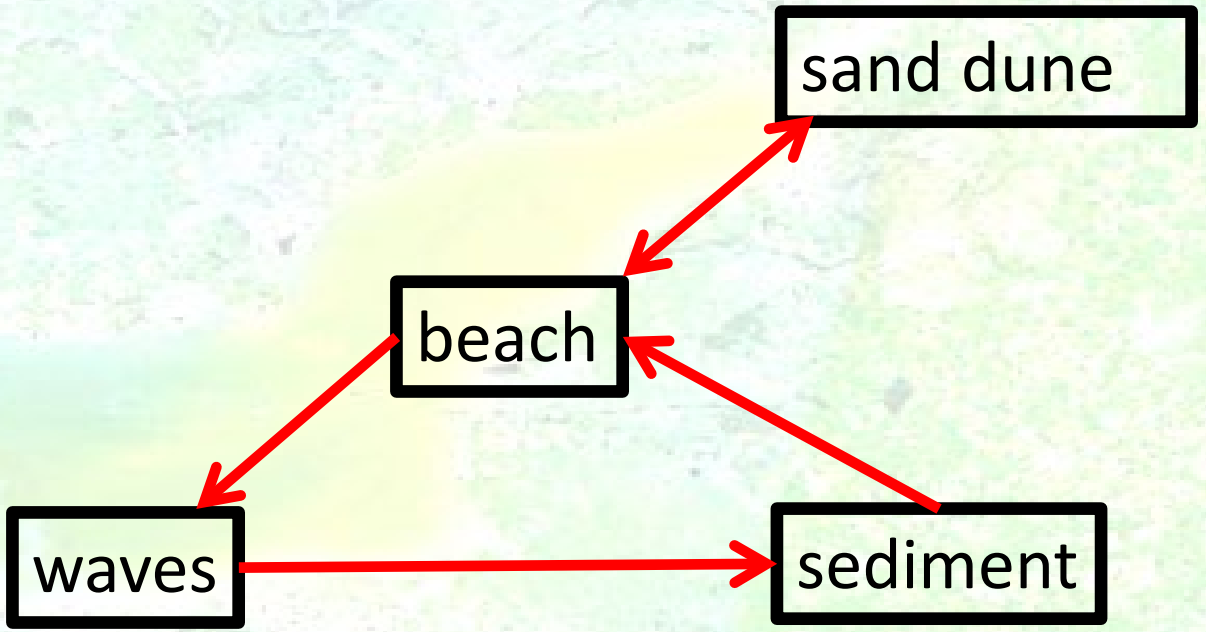
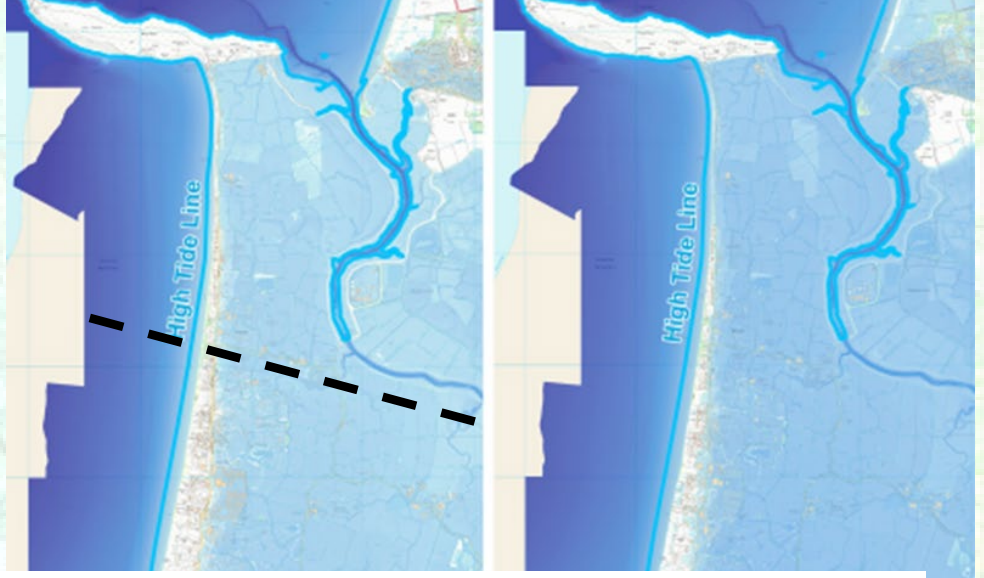
Will our beach and dune system still be able to cope?



What is at risk?

- extensive flooding of the Somerset Levels
- importance of the very narrow dune ridge



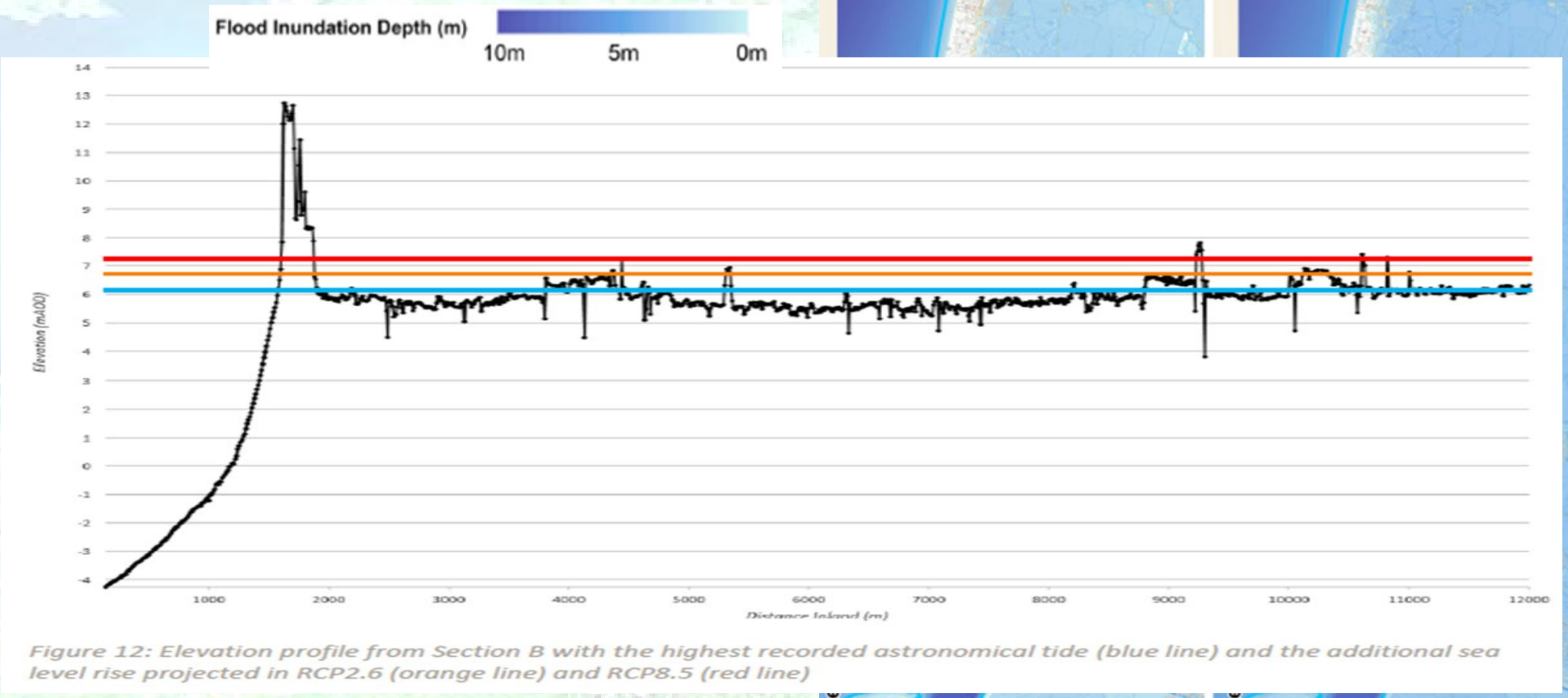


Figure 12: Elevation profile from Section B with the highest recorded astronomical tide (blue line) and the additional sea level rise projected in RCP2.6 (orange line) and RCP8.5 (red line)

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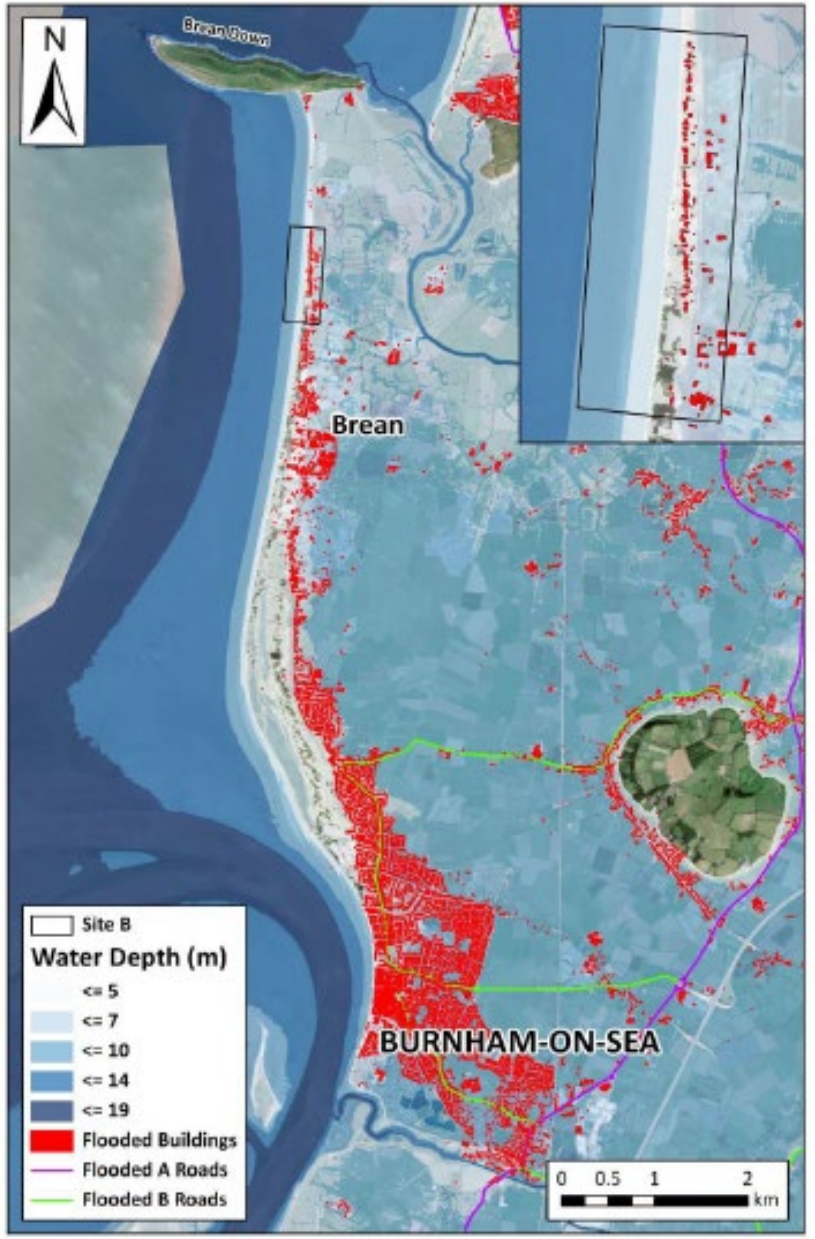
What is at risk?

- buildings and roads inundated
- significant environmental/economic/social impacts

Table 1. Asset damage calculations from flood inundation analysis.

Assets	Damage	Cost (£)		Reference
Cases Inundated		**Cost per Case**	**Total Flood Cost**	-
Buildings	28,964	30,000	868,935,000	Environment Agency (2015)
Extent (km)		**Cost per km**	**Total Flood Cost**	-
Railway	8.6	3,600,000	30,960,000	Severn Estuary Coastal Group (2010)
Motorway (M5)	9.5	14,000,000	133,000,000	
A Road	39.1	40,000	1,564,000	Environment Agency (2015)
B Road	30.0	100,000	3,000,000	
Area (km^2)		**Cost per km^2**	**Total Flood Cost**	-
Agriculture	78.2	5,775	451,605	Jongman et al. (2012)
Urban	9.1	34,820	316,862	Severn Estuary Coastal Group (2010)
Total Flood Cost Estimation (£)		1,038,227,467		

Figure 11. Potential extent of damage from worst-case scenario flooding from Brean Down to Burnham-on-Sea. Data sourced from Esri and Digimap (2019).



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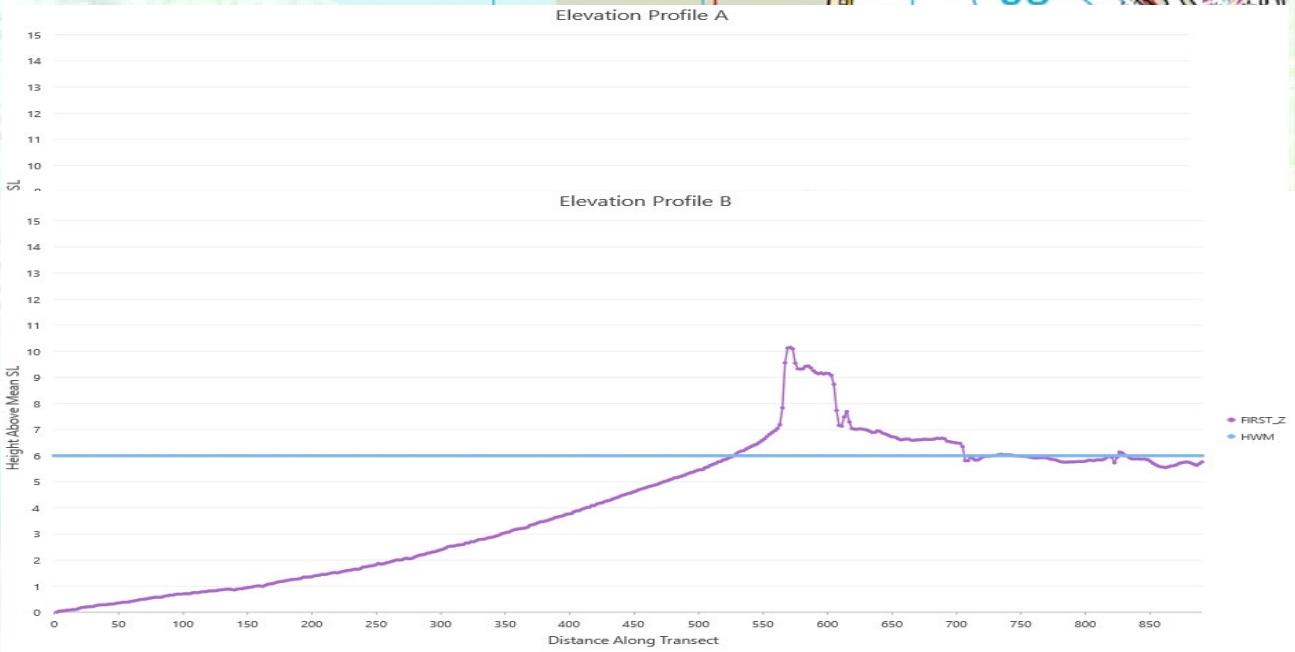
So where might we be concerned about?



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So where might we be concerned about?

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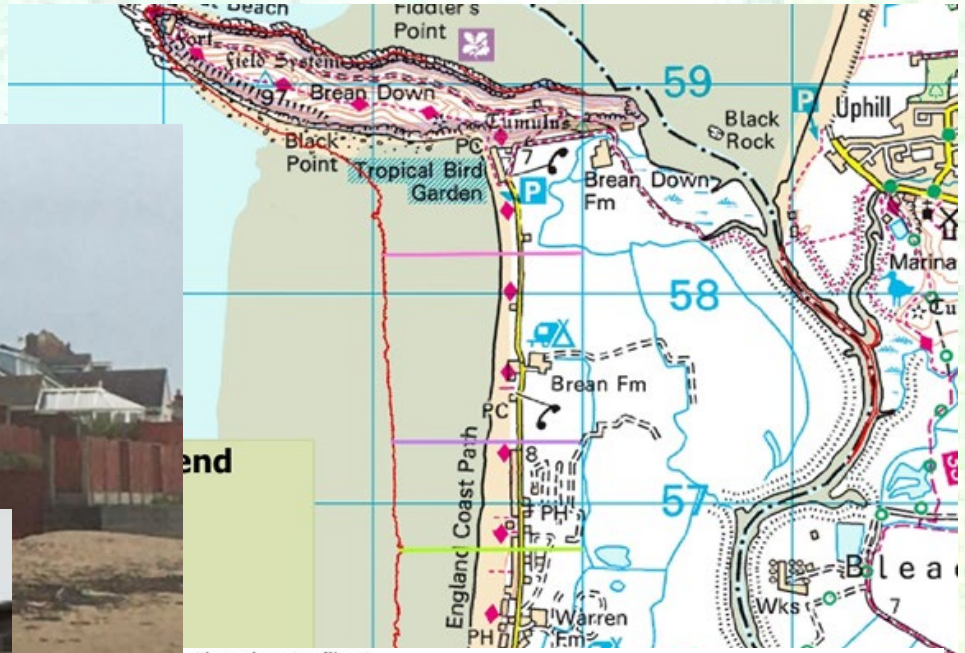
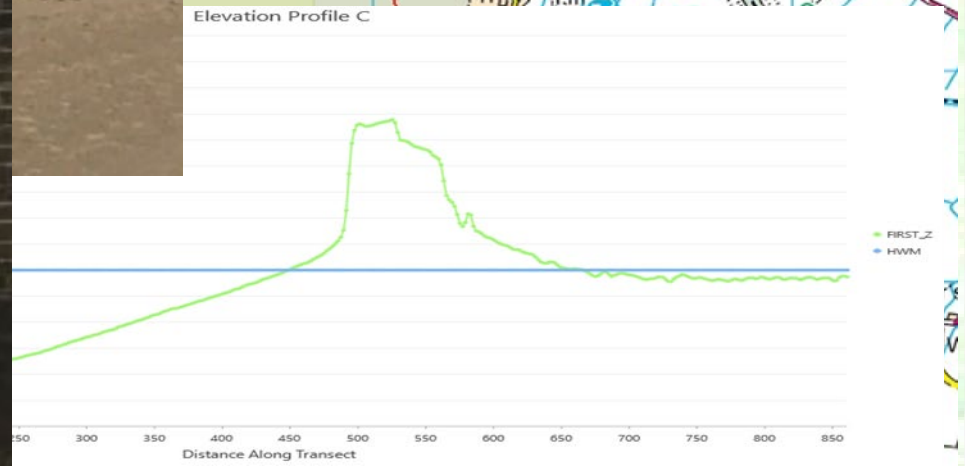
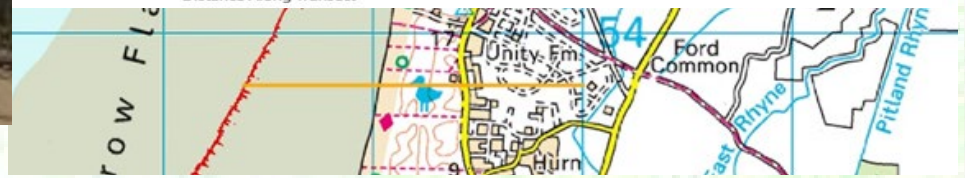
So where might we be concerned about?







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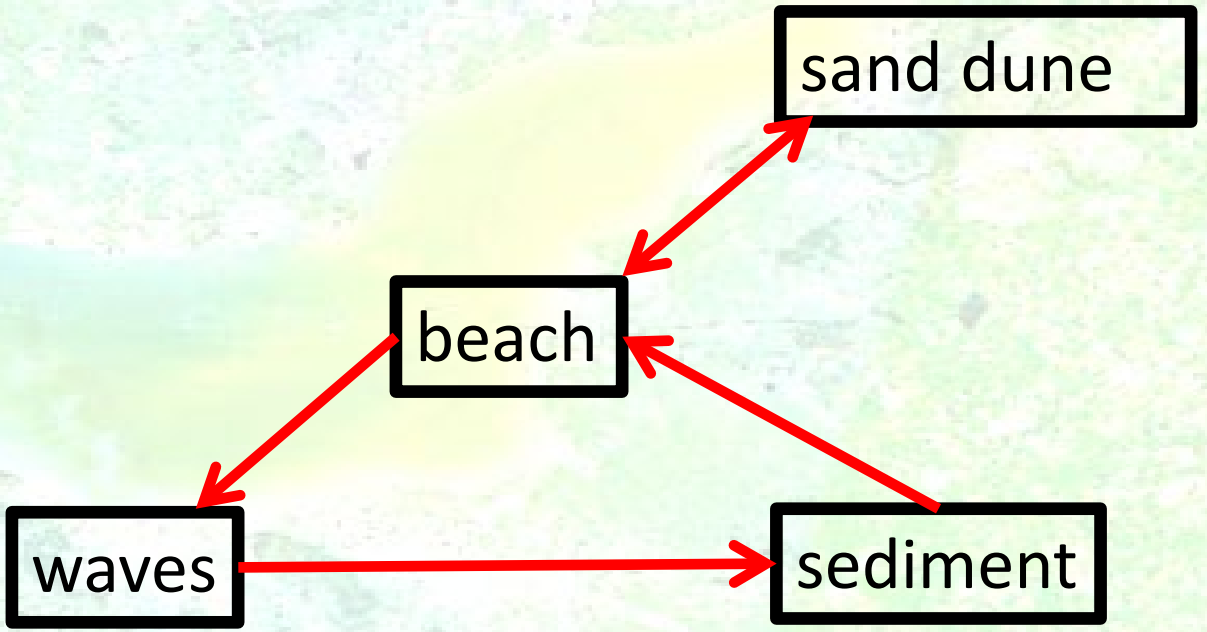
Current management issues at the site?

- very narrow ‘dune’ ridge
- ‘ad hoc’ coastal defences
- need management soon

Figure 12: Elevation profile from Section B with the highest recorded astronomical tide (blue line) and the additional sea level rise projected in RCP2.6 (orange line) and RCP8.5 (red line)

Options for CZM

Tourism disruption of the natural system.



Future approaches to coastal zone management (CZM)

- different approaches needed depending on the issues

- we need CZM when one of the 3 roles of the coast is threatened
  - defence
  - habitat
  - resource

- ….but how to decide on the approach to use?

- ***what criteria should we use to decide on the CZM approach?***

Coastal Management	Defence	Habitat	Resource	Cost	Local Geomorphology

Coastal Management	Defence	Habitat	Resource	Cost	Local Geomorphology
Hard Engineering					
Sea wall					
Rock armour					
Offshore breakwaters					
Gabions					
Groynes					
Geotube					
Soft Engineering					
Beach nourishment					
Dune Management					
Saltmarsh development					
Managed Retreat					

Coastal management responses cost

Technique	Relative Costs				
	Design and Permitting	**Construction**	**Expected Maintenance Frequency[1]**	**Average Annual Maintenance Costs[2]**	**Average Annual Mitigation Costs[3]**
Artificial Dunes & Dune Nourishment	Low	Low	1-5 years	Low	None
Controlling Overland Runoff	Low	Low	5-20 years	Low	None
Planting Vegetation	Low	Low	1-3 years	Low	None
Bioengineering - Coir Rolls on Coastal Banks	Low-Medium	Medium-High	1-3 years	Low-Medium	Low
Bioengineering - Natural Fiber Blankets on Coastal Banks	Low	Low	1-3 years	Low	None
Sand Fencing	Low	Low	3-5 years	Low	None
Beach Nourishment	Medium	Low-Medium	5-10 years	Low	Low
Rock Revetments - Toe Protection	High	High	10-20 years	Low	Low- Medium
Rock Revetments - Full Height (up to predicted flood zone elevation)	Very High	Very High	20-25 years	Low	Medium
Seawall	High-Very High	Very High	25-40 years	Low	Medium-High

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

https://www.mass.gov/files/documents/2016/09/tm/cost-comparison-chart.pdf

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Options for CZM

Good for defence/habitat/resource?

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Beach nourishment

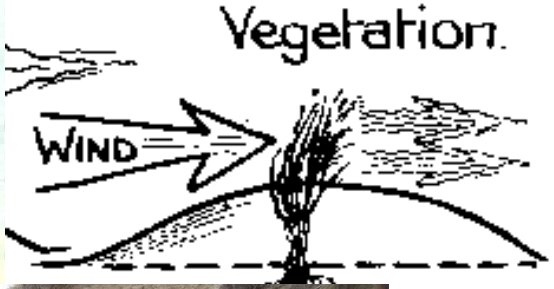
Figure 1. Aerial photograph of the Sand Engine after completion (September 2011) looking southward. Picture courtesy of Rijkswaterstaat/Joop van Houdt.

Good for defence/habitat/resource?

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?

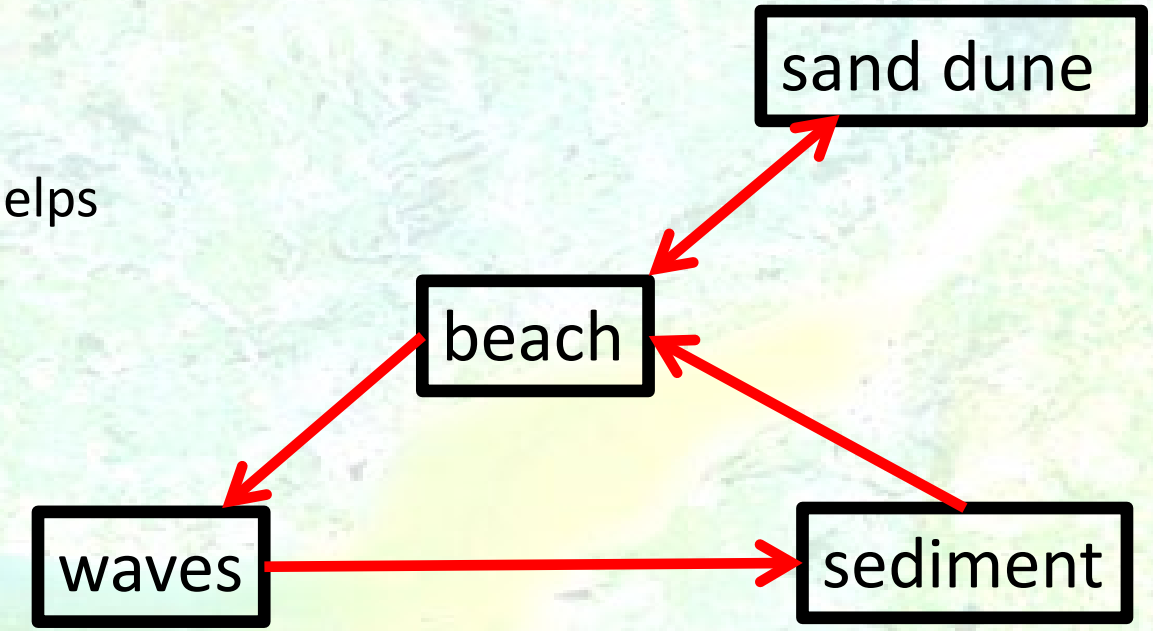
Consider the narrow poorly defended area.

Coastal Management	Defence	Habitat	Resource	Cost	Local Geomorphology
Hard Engineering					
Sea wall					
Rock armour					
Offshore breakwaters					Tidal range
Gabions					
Groynes					No longshore drift
Geotube					
Soft Engineering					
Beach nourishment					
Dune Management					Realistic?
Saltmarsh development					Lots of mud available
Managed Retreat					

Coastal management responses :

Soft engineering solutions - dunes

- systems approach to understanding coasts helps



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

Summary:

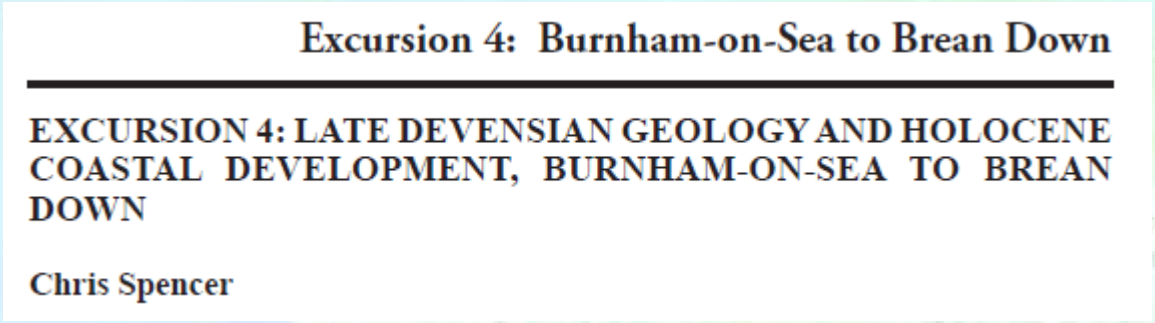
- Location is important locally & nationally human/physical environment
- Has a history of flooding and the situation will worsen with climate change
- A range of response are required to provide defence / habitat / resource

Only with a detailed understanding of the physical environment and also the human pressures that are placed on it can we manage this coastline into the future….

…geographers are very well placed to deliver this….

Resources :

- Time for Geography – Coastal management videos
- https://timeforgeography.co.uk/videos_list/coasts/



Excursion 4: Burnham-on-Sea to Brean Down

EXCURSION 4: LATE DEVENSIAN GEOLOGY AND HOLOCENE COASTAL DEVELOPMENT, BURNHAM-ON-SEA TO BREAN DOWN

Chris Spencer

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Another case study- Dawlish Warren : https://www.youtube.com/watch?v=mvBkGHKwRgo

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