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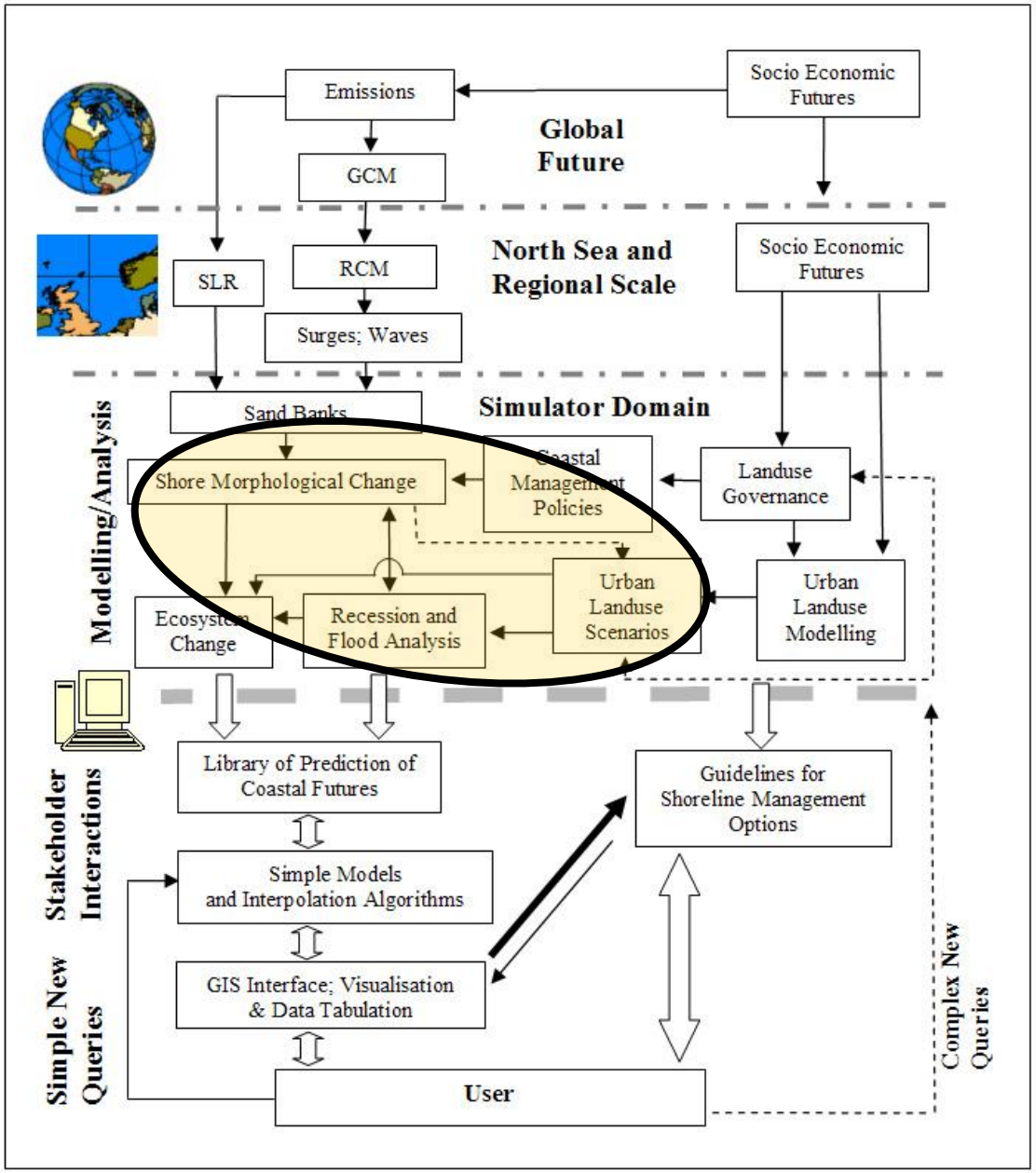
for Climate Change Research

Erosion and flood risk analysis

Jim Hall, Xingzheng Wu,
Mike Walden, Nicolas Roche,
Richard Dawson

Newcastle University

Tyndall Coastal Simulator



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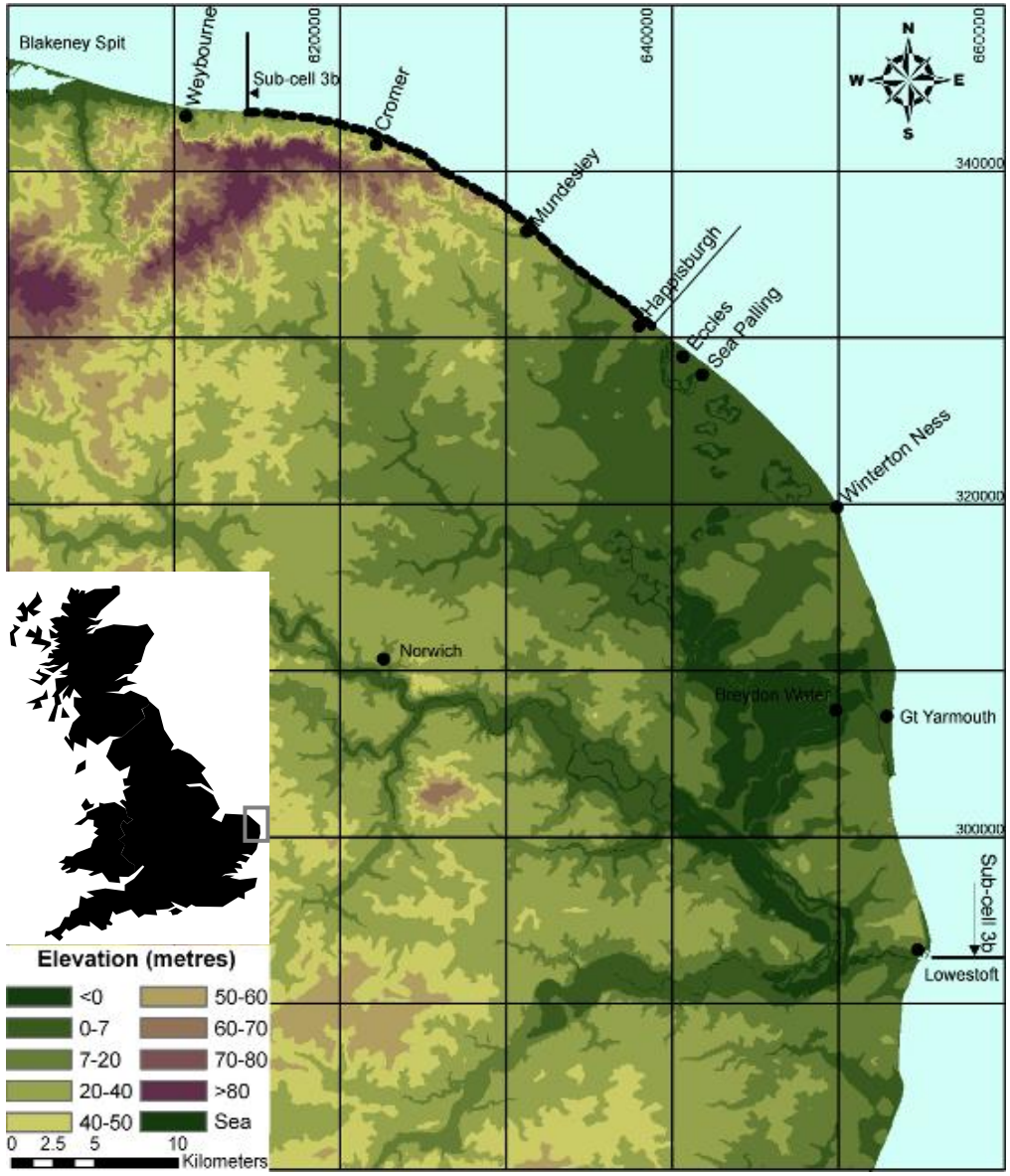

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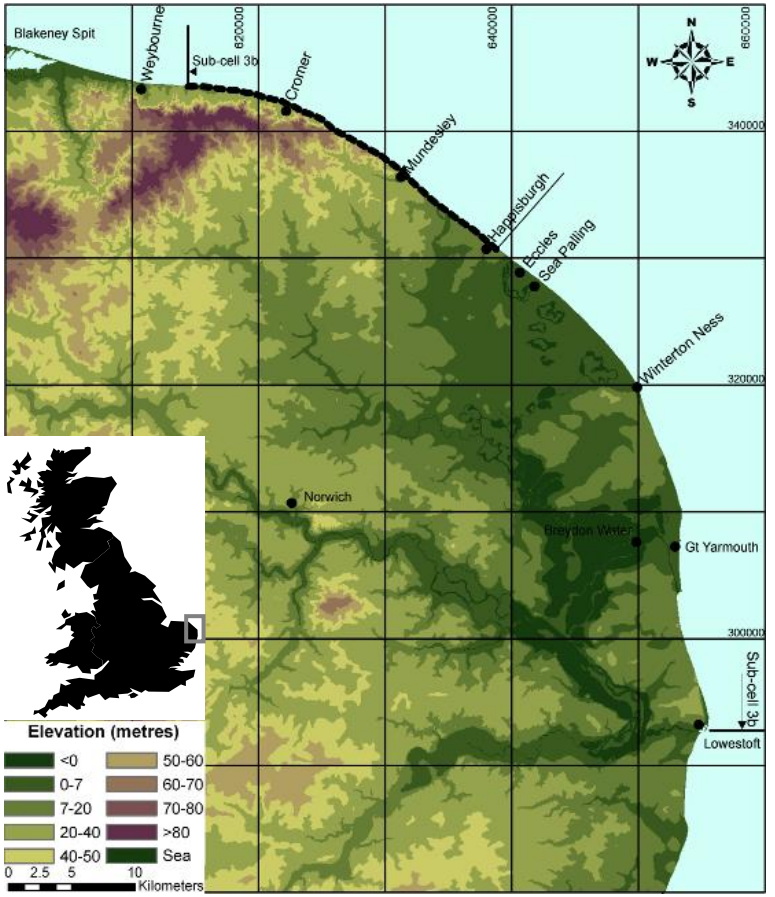

Sediment flux along the flood vulnerable coast

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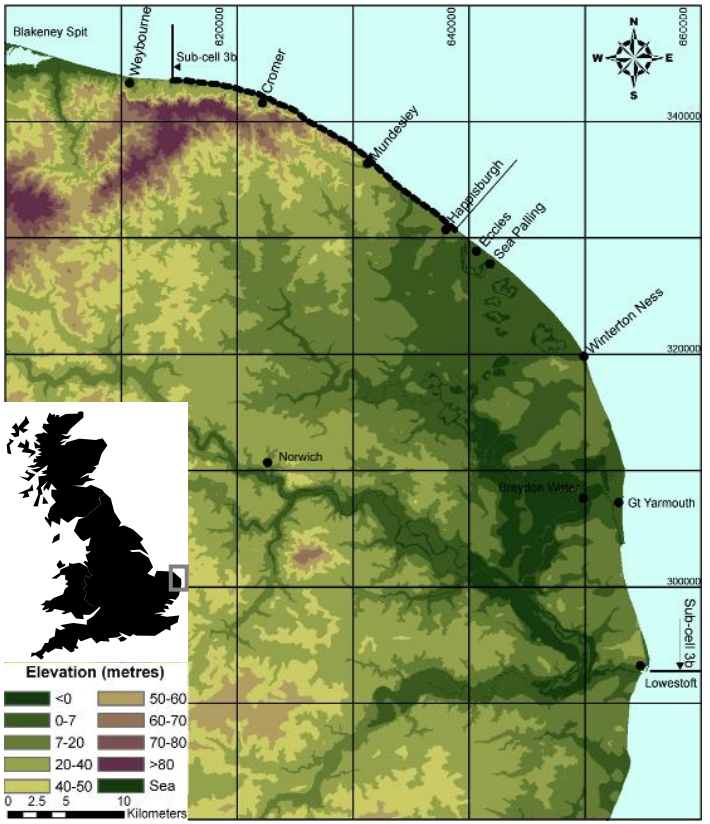

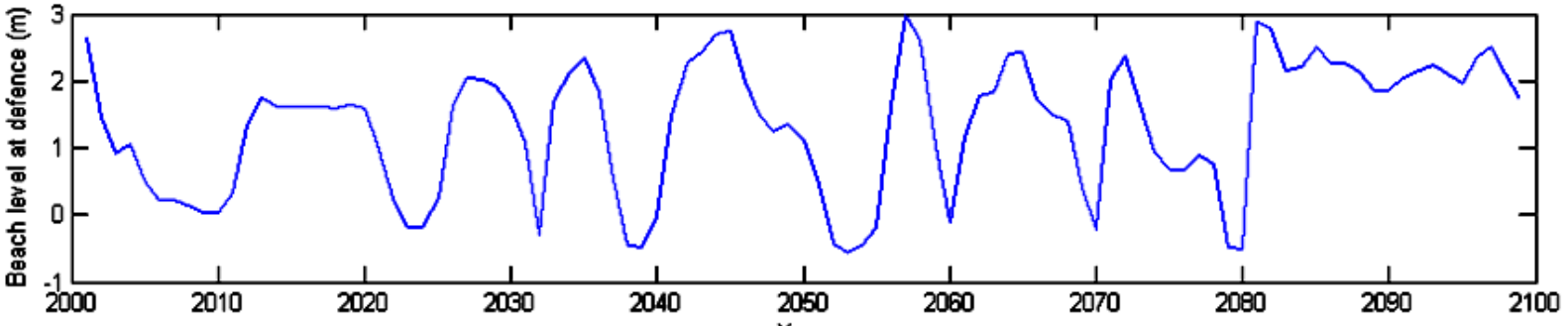

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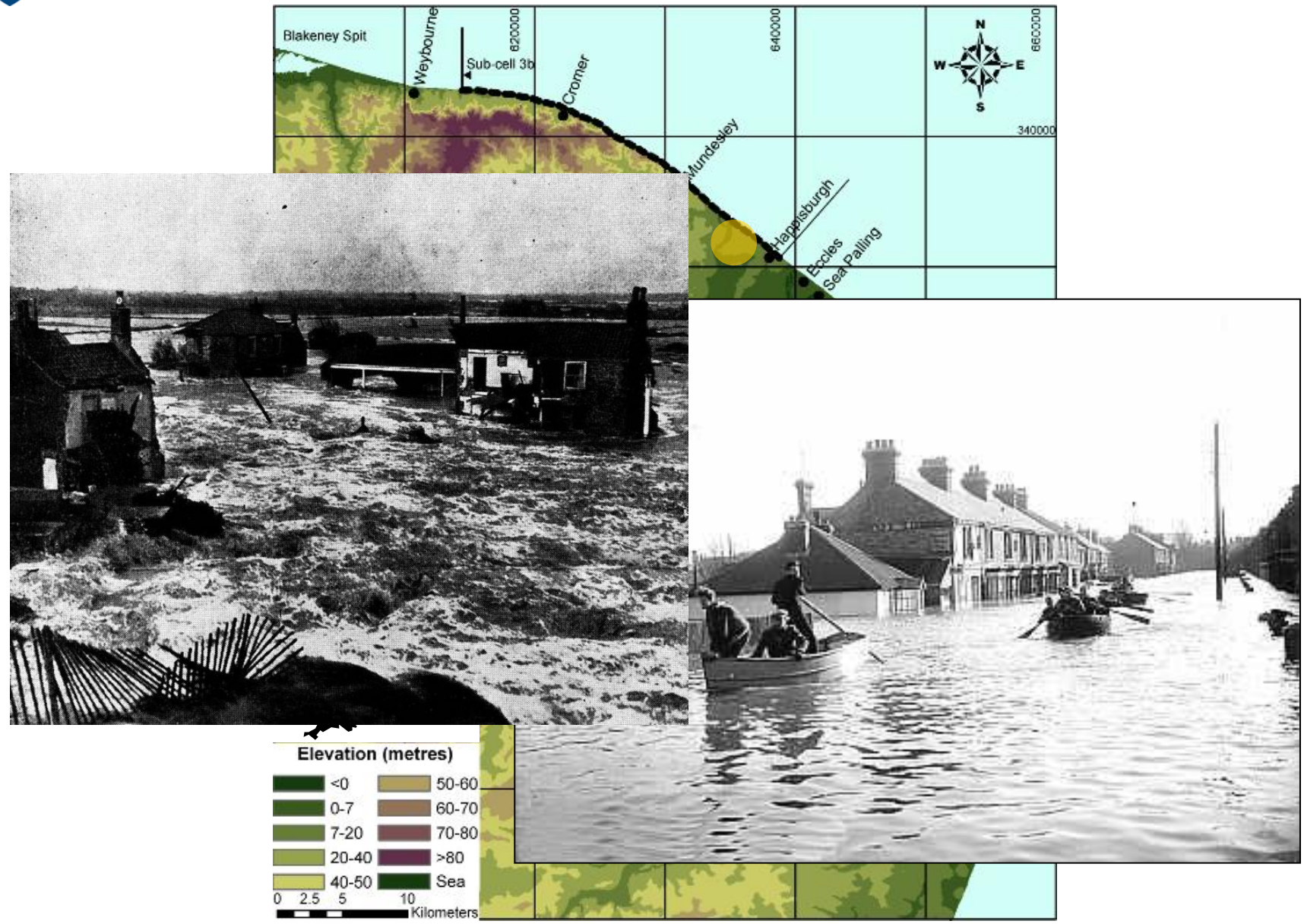
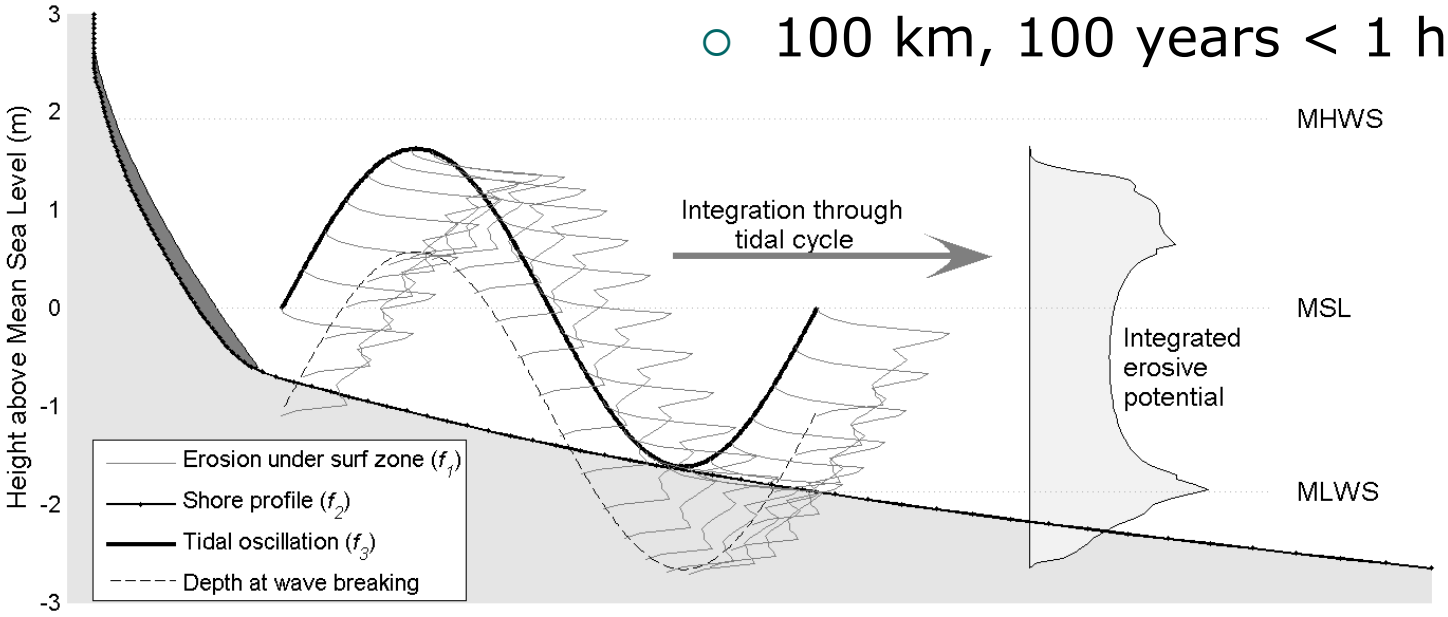


SCAPE

- Soft Cliff And Platform Erosion
- Based on work by Kamphuis, Nairn, Skafell and Bishop
- Published in Coastal Engineering 2005 (Walkden & Hall)
- Includes beach, platform and cliff
- Tidal timestep
- Physical basis but with reduced complexity, for larger scales and faster run times
- 100 km, 100 years < 1 hour



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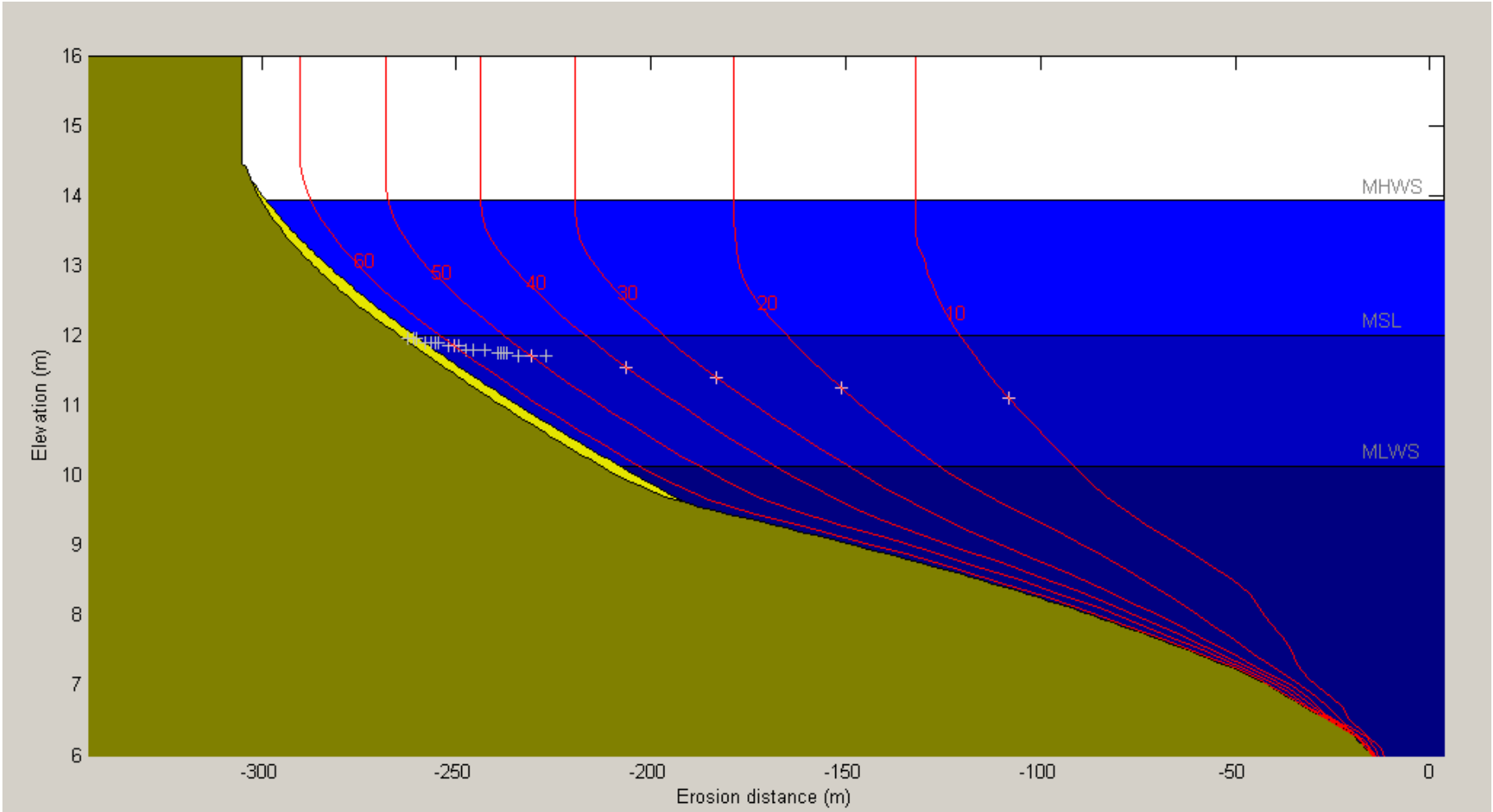
SCAPE profile development



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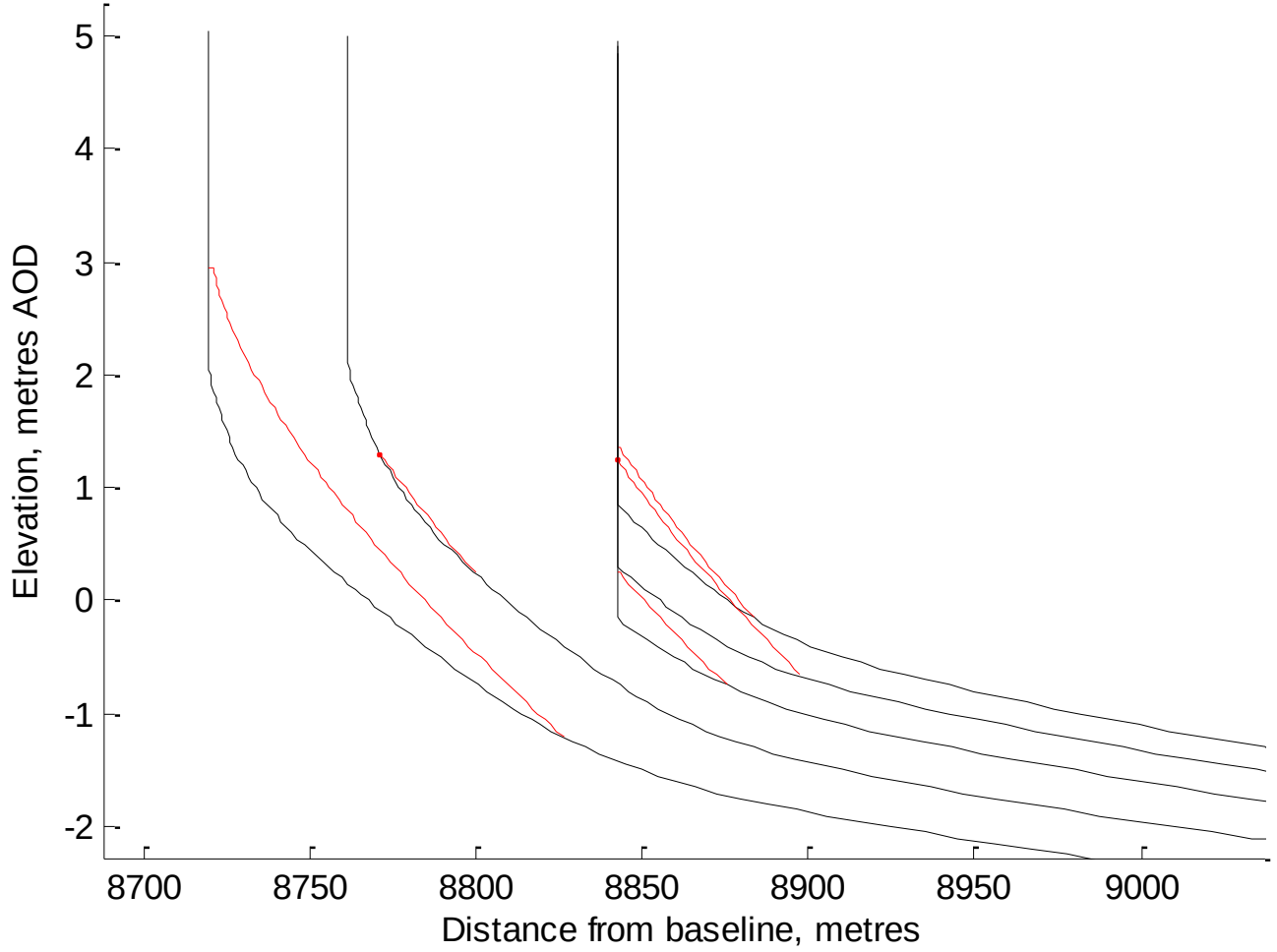
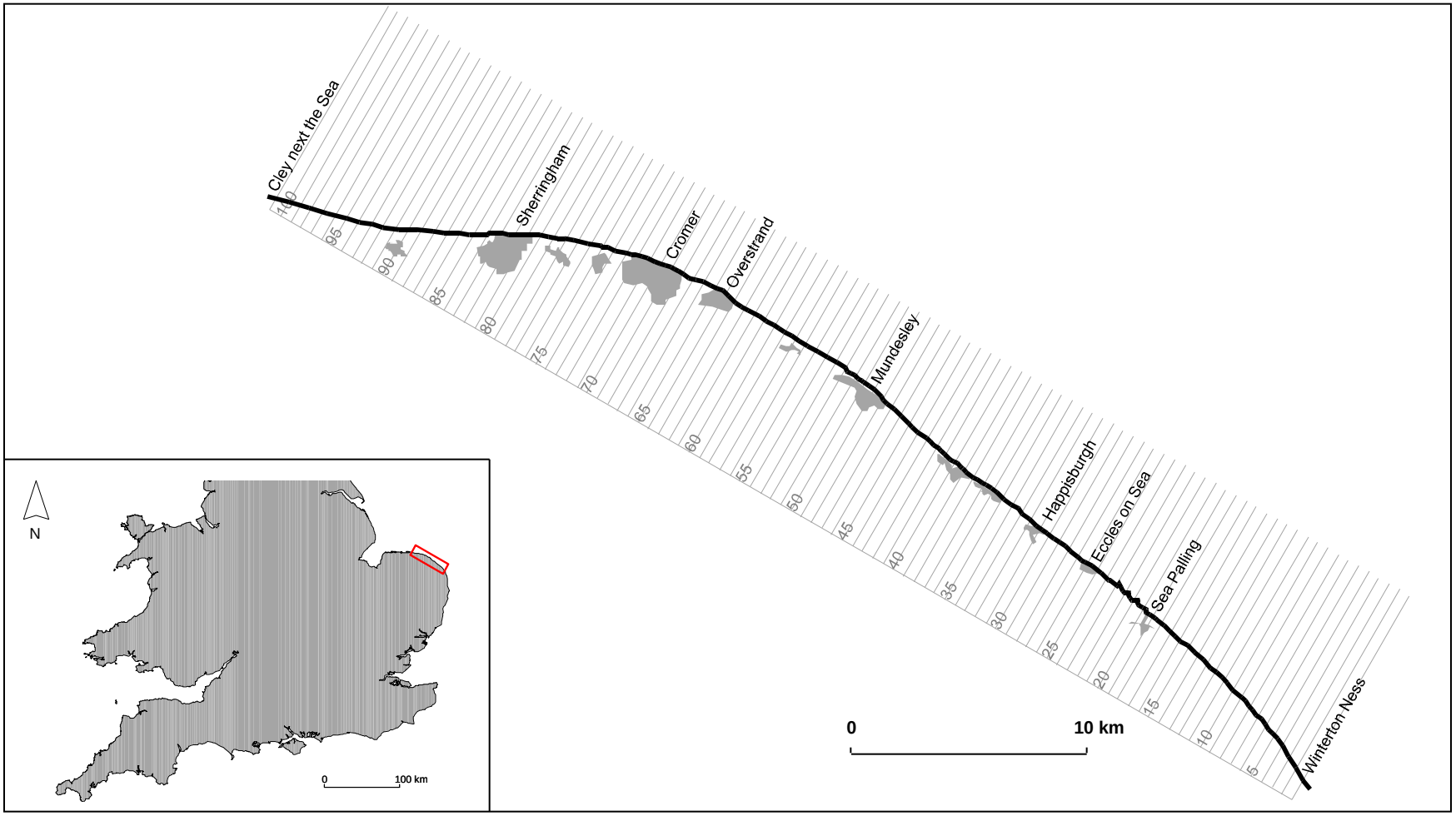
Cliff rebound after seawall failure



Assembly of Norfolk model sections



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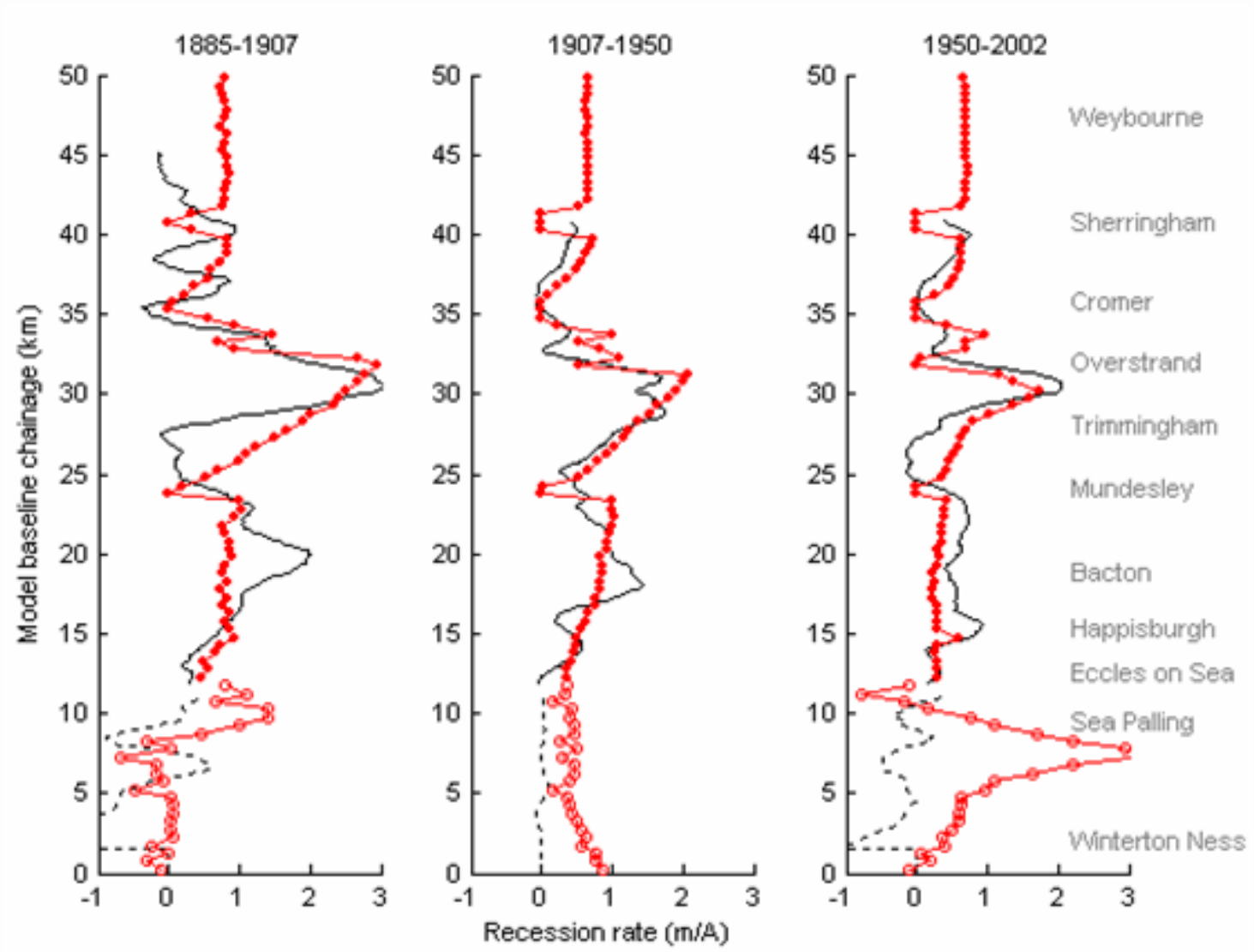
Model testing



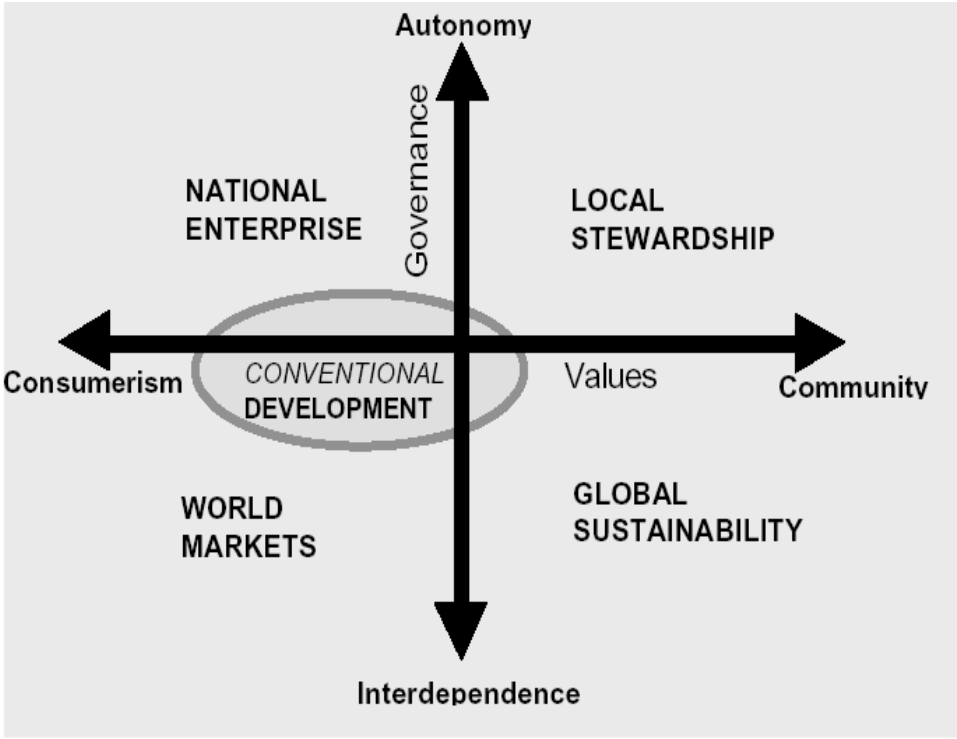
Future simulation uncertainties

Scenarios of greenhouse gas emissions -> probabilistic climate. Currently only sea-level rise, waves and surge to be added

Management (scenarios)

Currently 5, based on removal or development of existing defences

Socio-economic development (scenarios).



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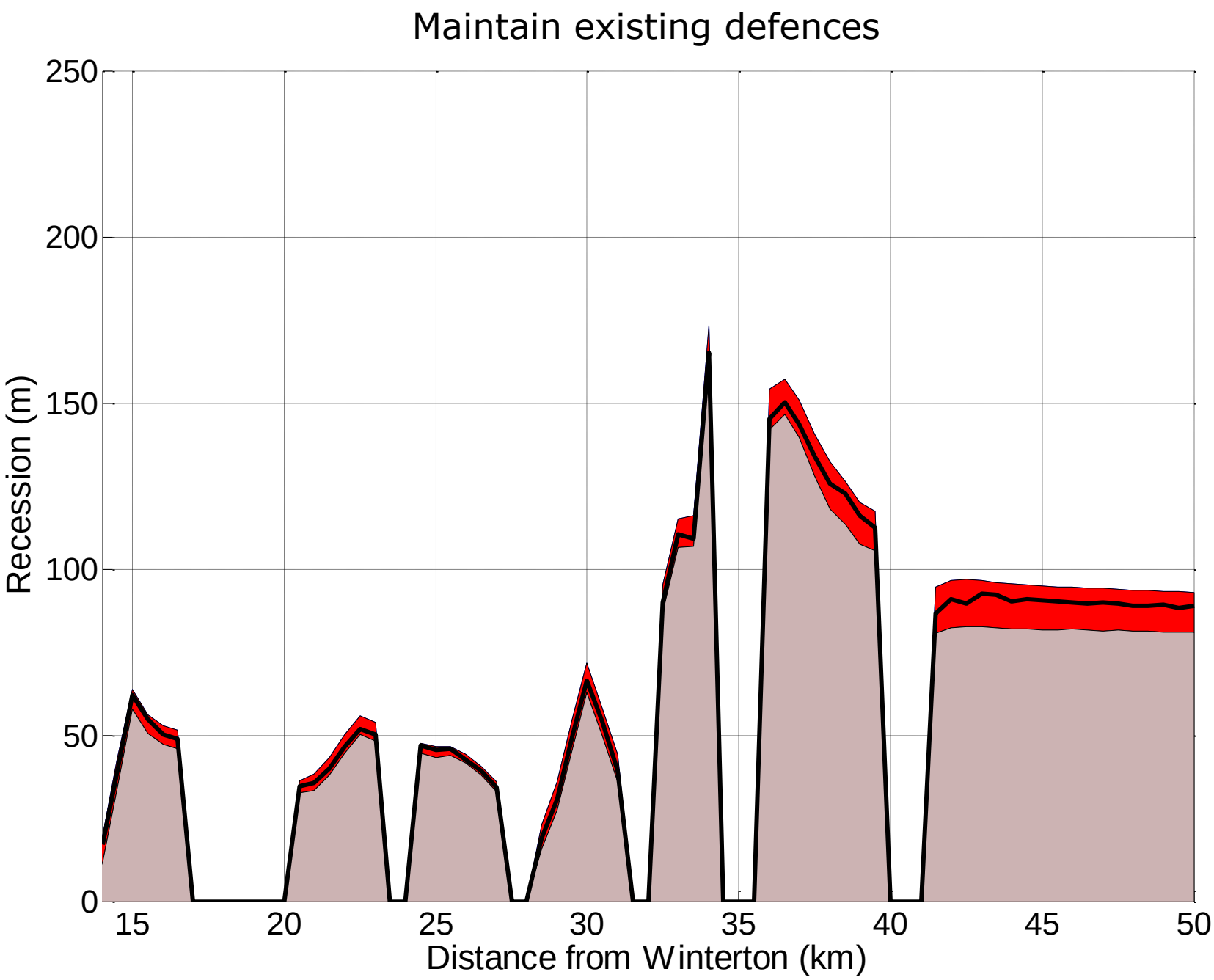
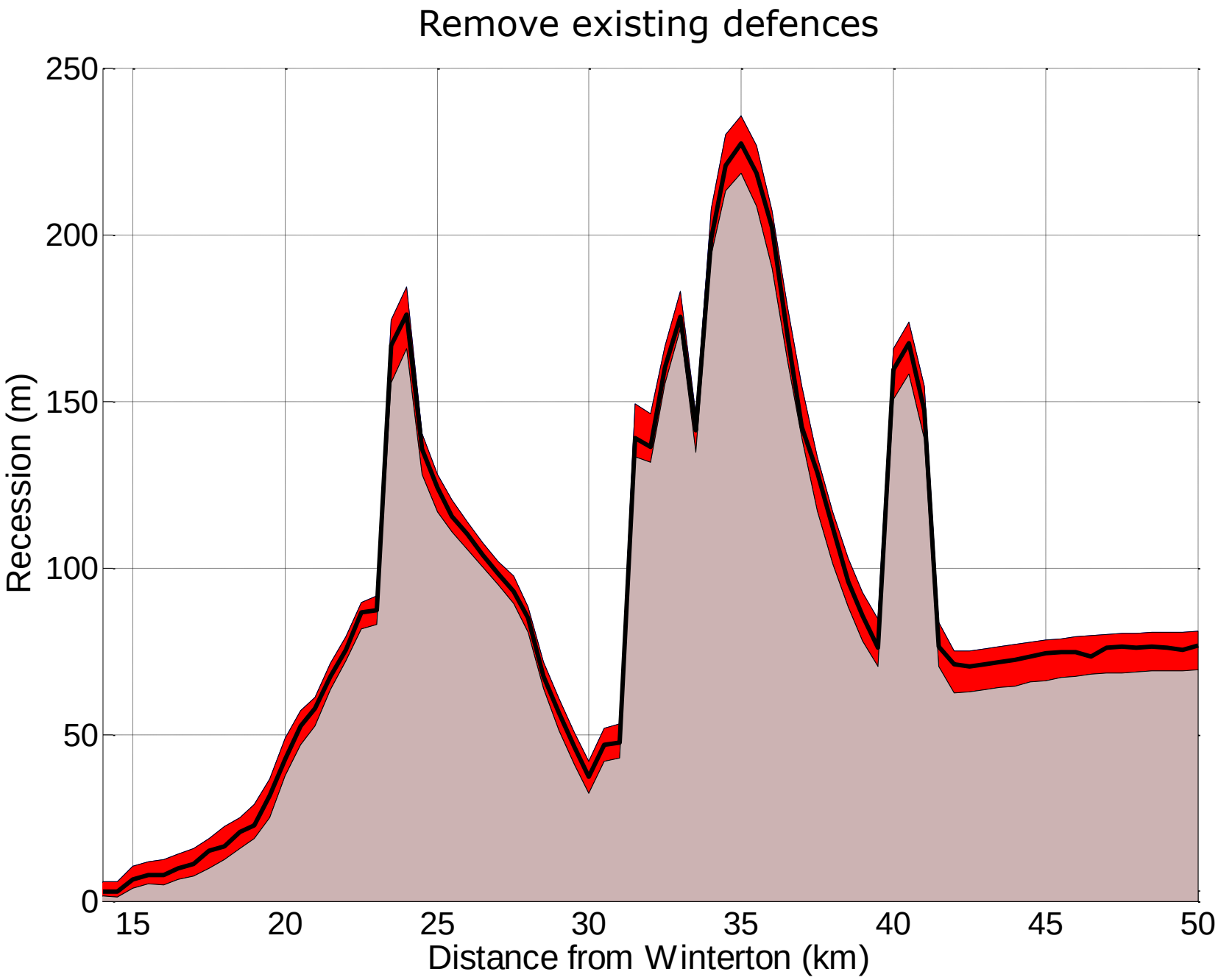
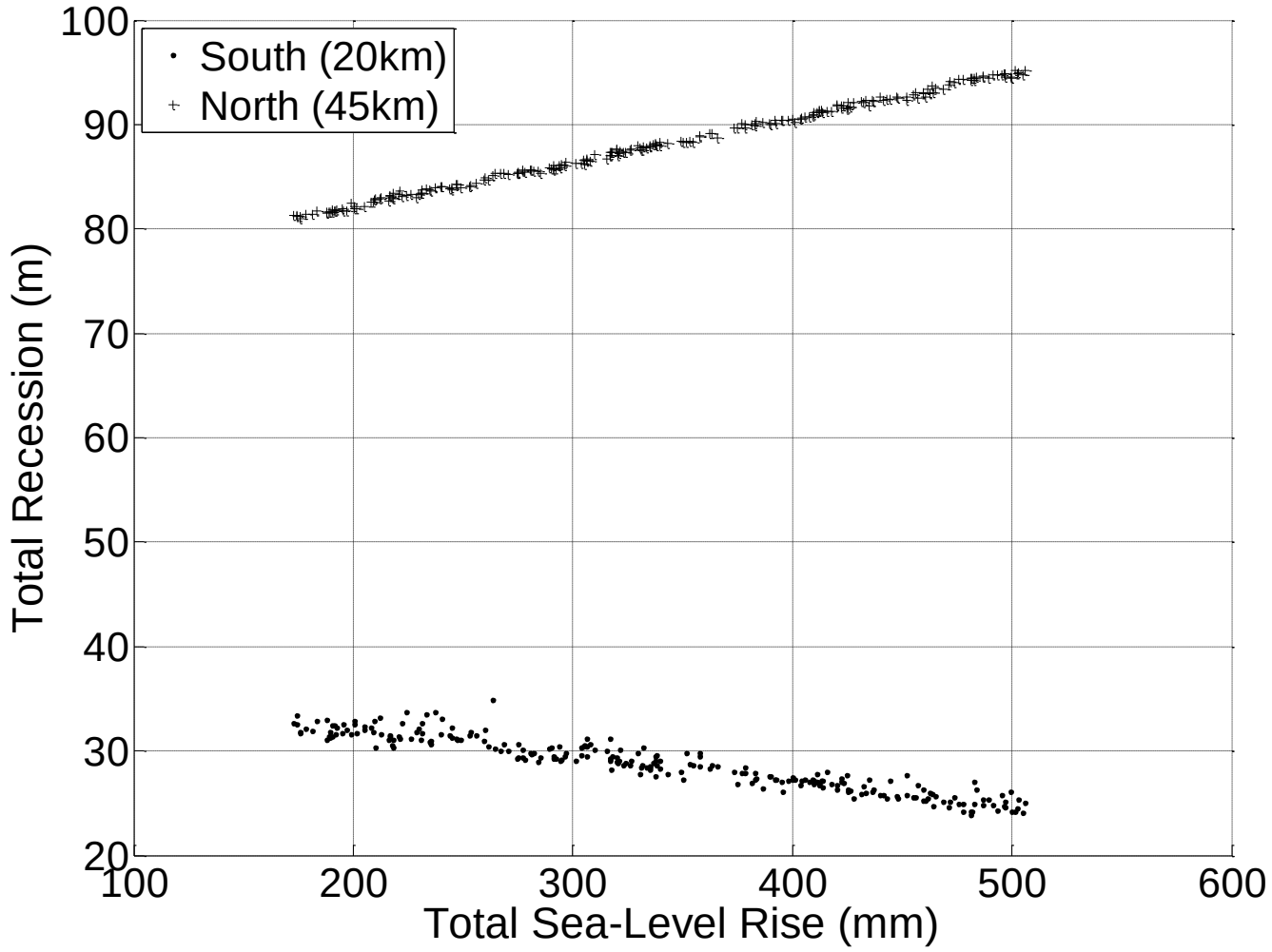
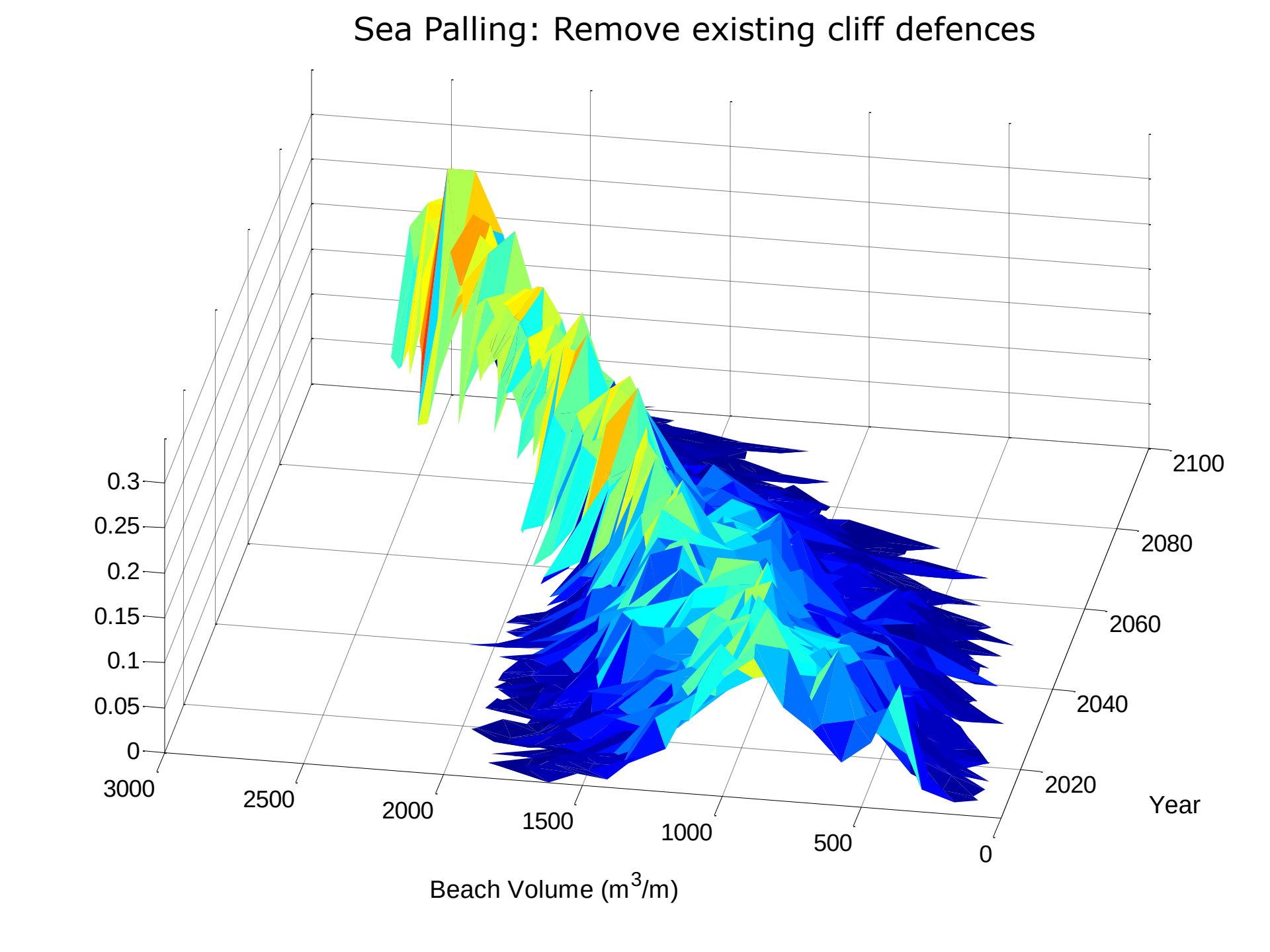
Scenarios and management options

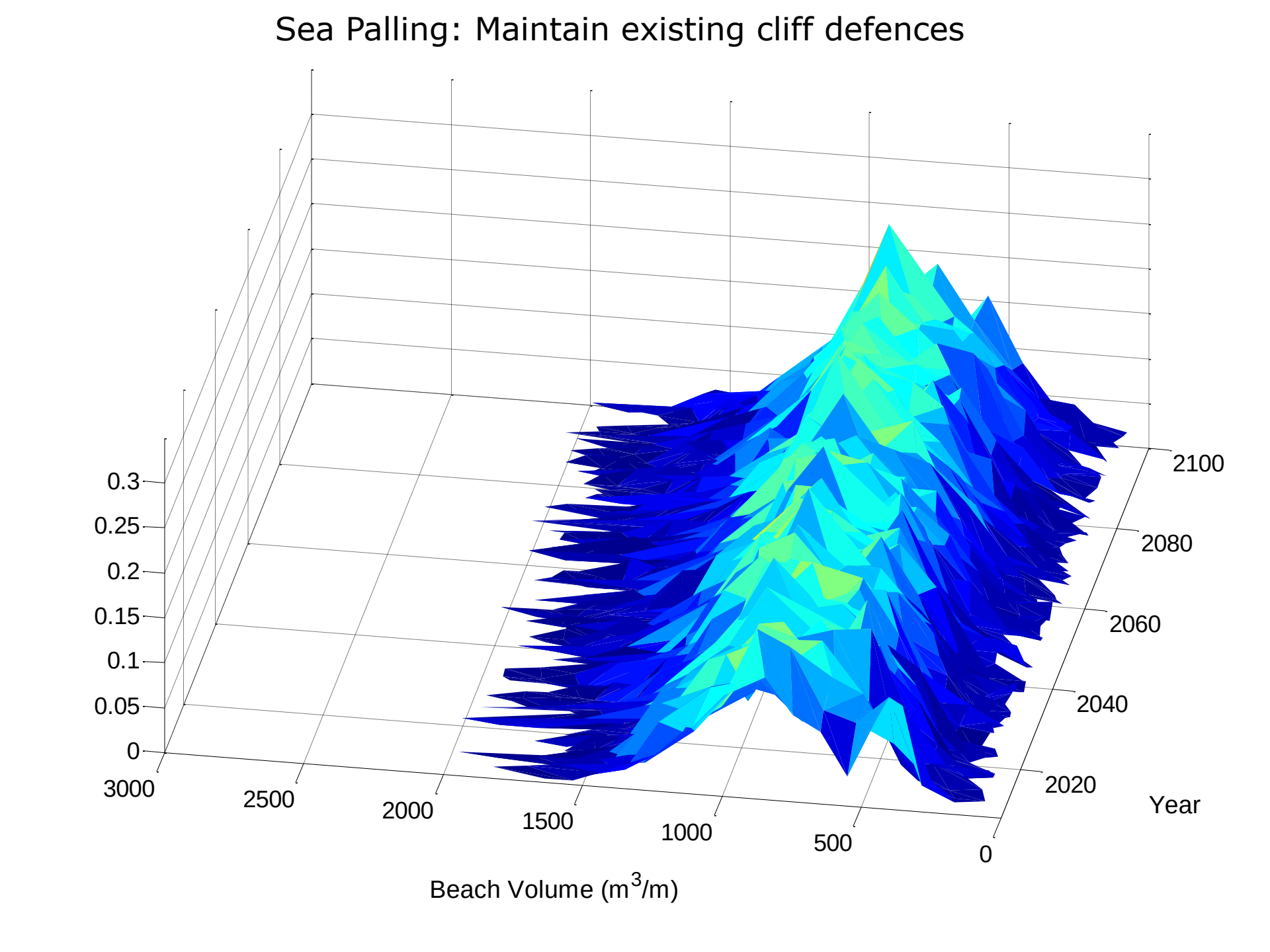
Emissions	Global Temp /SLR (m)	Management	Measures	Socio-economic	Socio-economic
B1	Low 0.18 – 0.38	M1	Removal of all defences	WM	World Markets
A1B	Medium 0.21 – 0.48	M2	'SMP'	NE	National Enterprise
A1F1	High 0.26 – 0.59	M3	Maintain existing defences	GS	Global Sustainability
High ++		M4	Construct seawalls everywhere	LS	Local Stewardship
		M5	The 'SMP', without beach nourishment	BU	Business as Usual


Maintain existing defences
Recession (m)
250
200
150
100
50
0
15
20
25
30
35
40
45
50
Distance from Winterton (km)


Remove existing defences
250
200
150
100
50
0
Recession (m)
15
20
25
30
35
40
45
50
Distance from Winterton (km)


South (20km)
North (45km)
Total Recession (m)
Total Sea-Level Rise (mm)
100
90
80
70
60
50
40
30
20
100
200
300
400
500
600


Sea Palling: Remove existing cliff defences
0.3
0.25
0.2
0.15
0.1
0.05
0
3000
2500
2000
1500
1000
500
0
Beach Volume (m3/m)
2100
2080
2060
2040
2020
Year


Sea Palling: Maintain existing cliff defences
0.3
0.25
0.2
0.15
0.1
0.05
0
3000
2500
2000
1500
1000
500
0
Beach Volume (m3/m)
2100
2080
2060
2040
2020
Year

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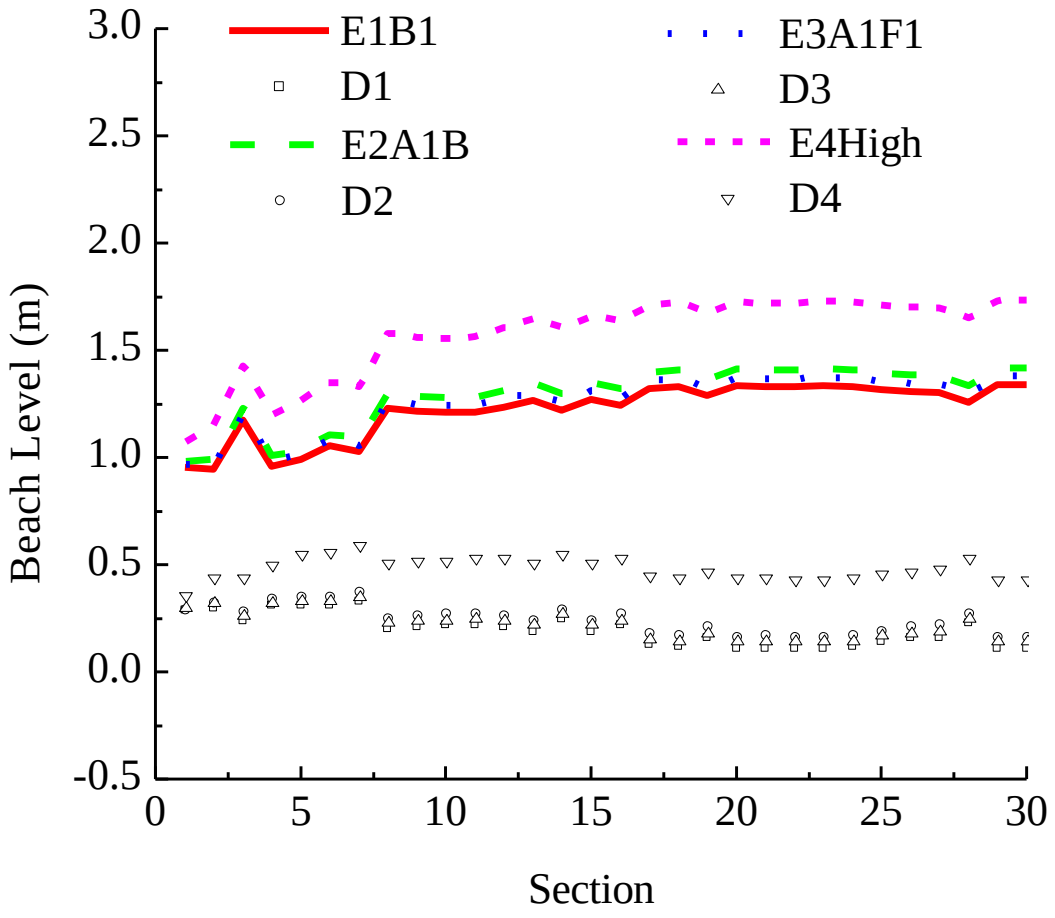
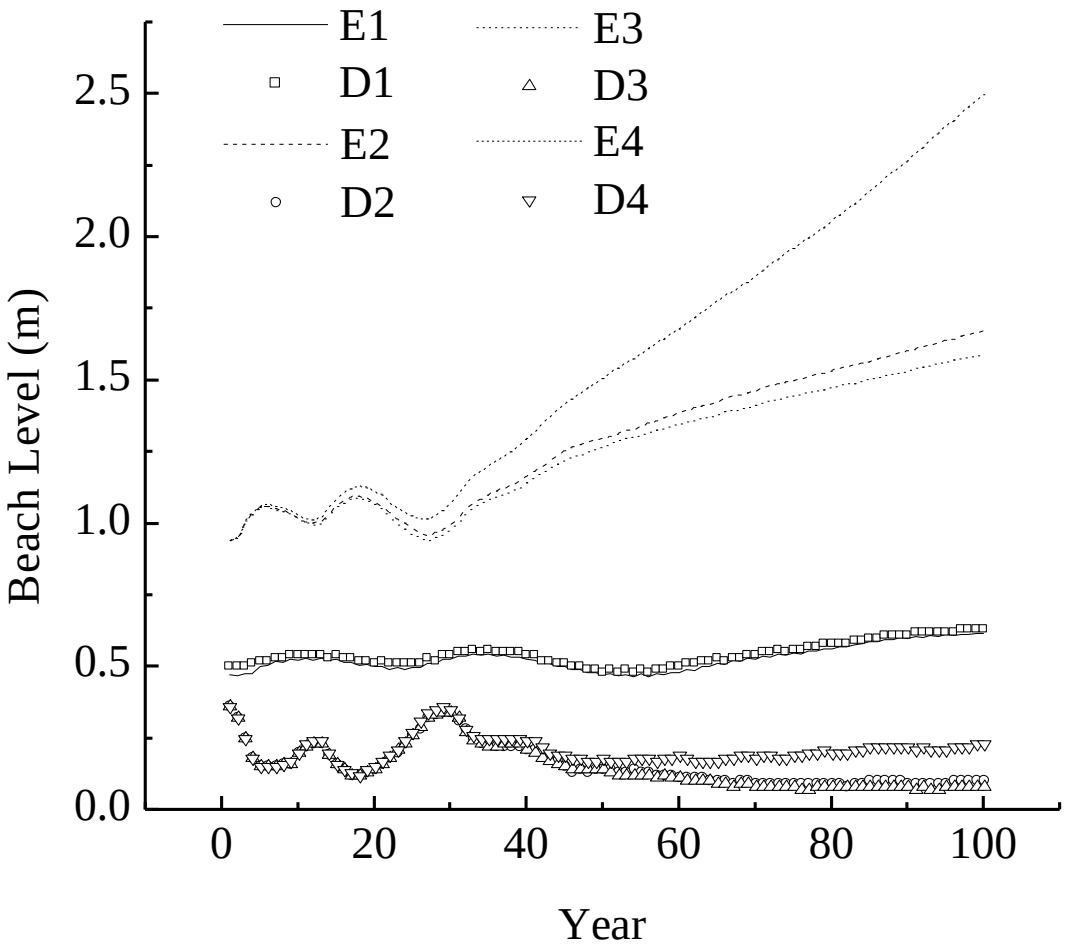
Spatial distribution of beach level for various sea level rise scenarios



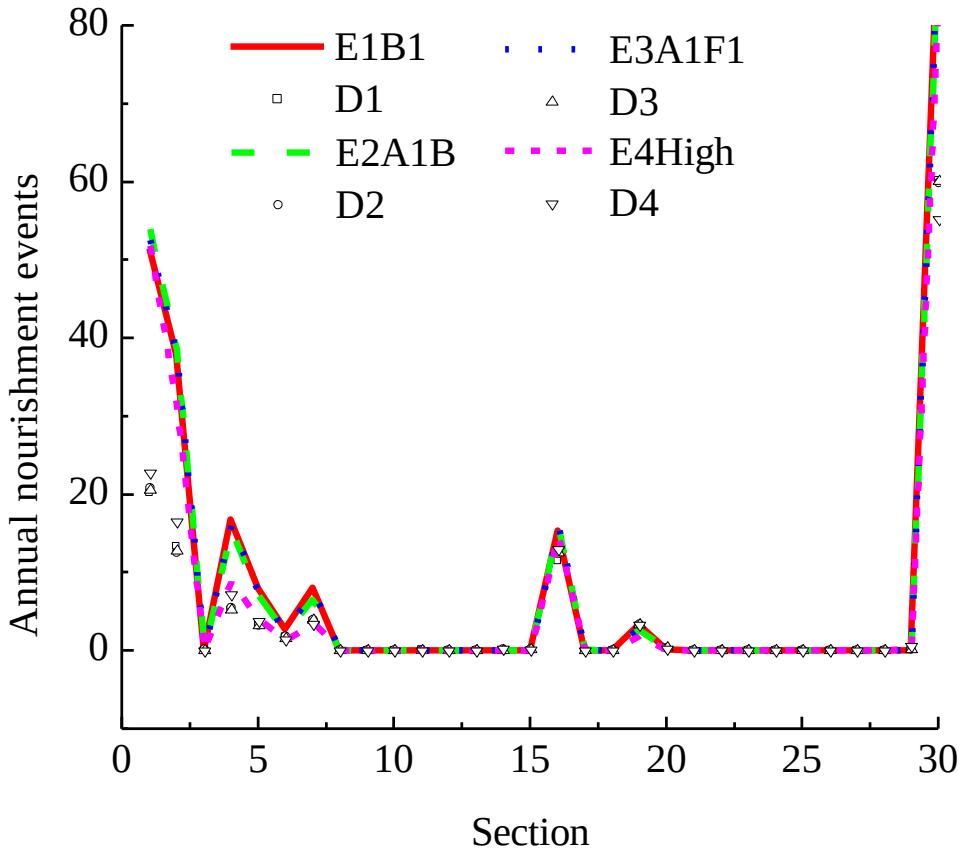
Annualbeachlevel_SectStatE1-E4M5VB Fig2.46CP.opj

Temporal distribution of beach level for various sea level rise scenarios



Annualbeachlevel_TempStatE1-E4M5VB Fig2.51CP.opj

Number of nourishment events for various Management scenarios



[E-ALL, M-manage5] Fig 1.24CP.opj

Beach nourishment trigger levels

Area	**Action Level**	**Emergency Level**
Cart Gap to Reef 5	+0.2mOD	-0.5mOD
Reef 5 to Reef 13	+0.2mOD for gaps between reefs -1.0mOD for seaward end of salients	-0.5mOD
Reef 13 to Winterton-on-Sea	+2.0mOD	0.0mOD

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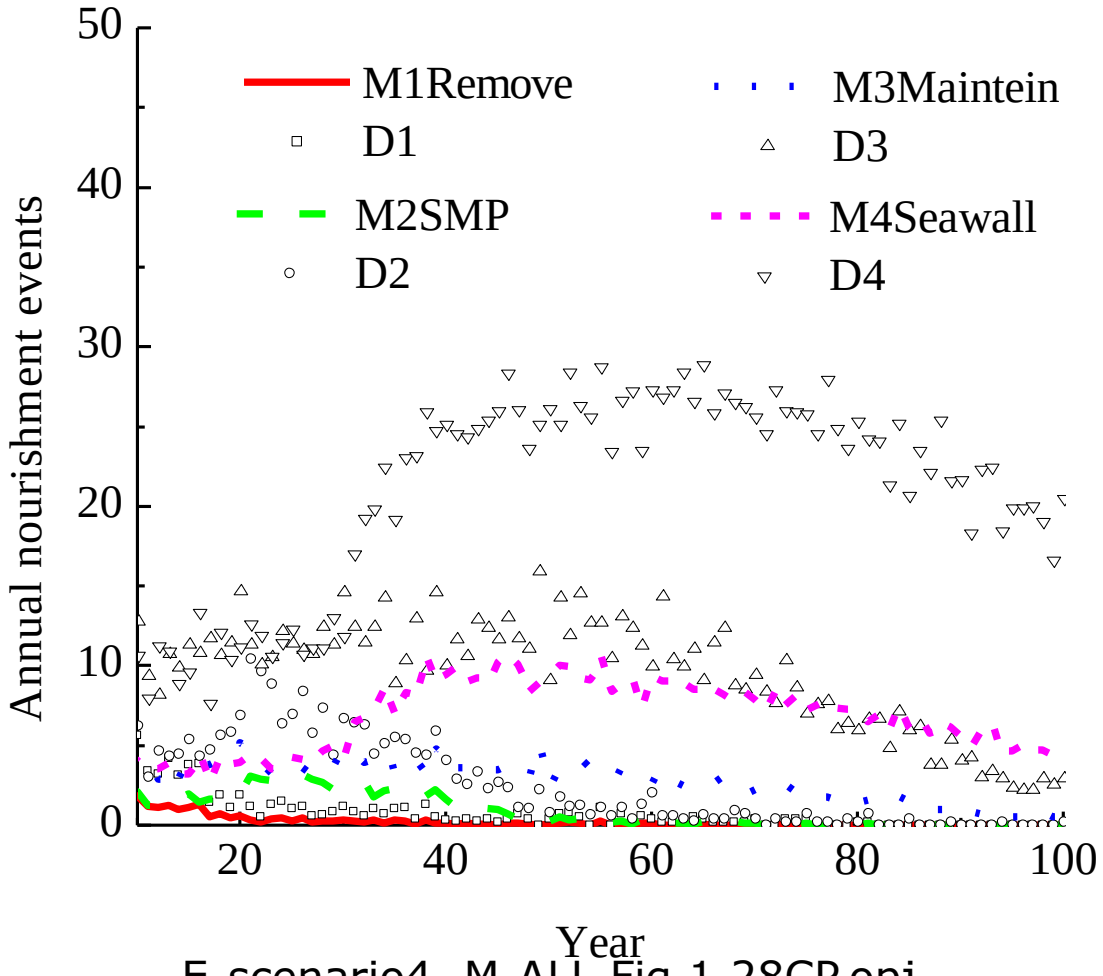
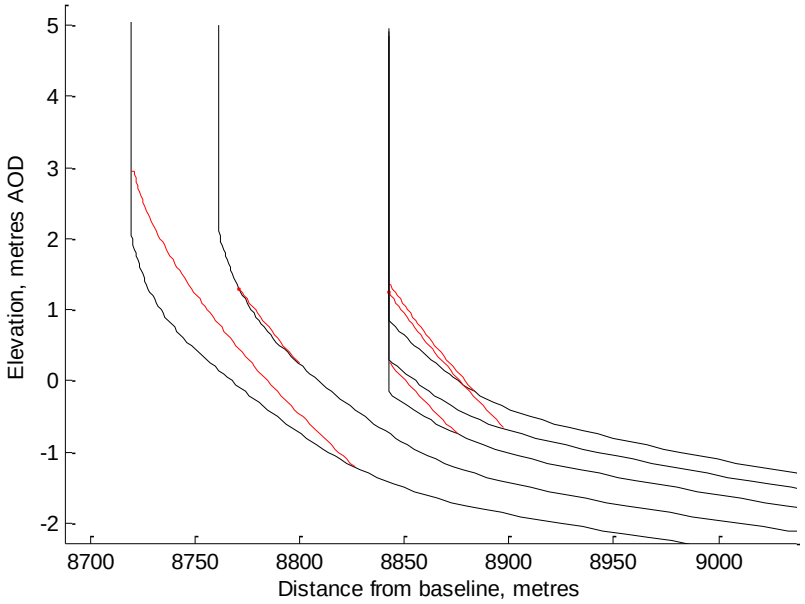
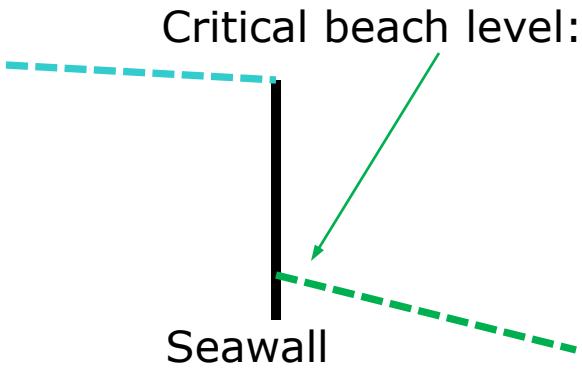
Timescale of nourishment events for various management scenarios



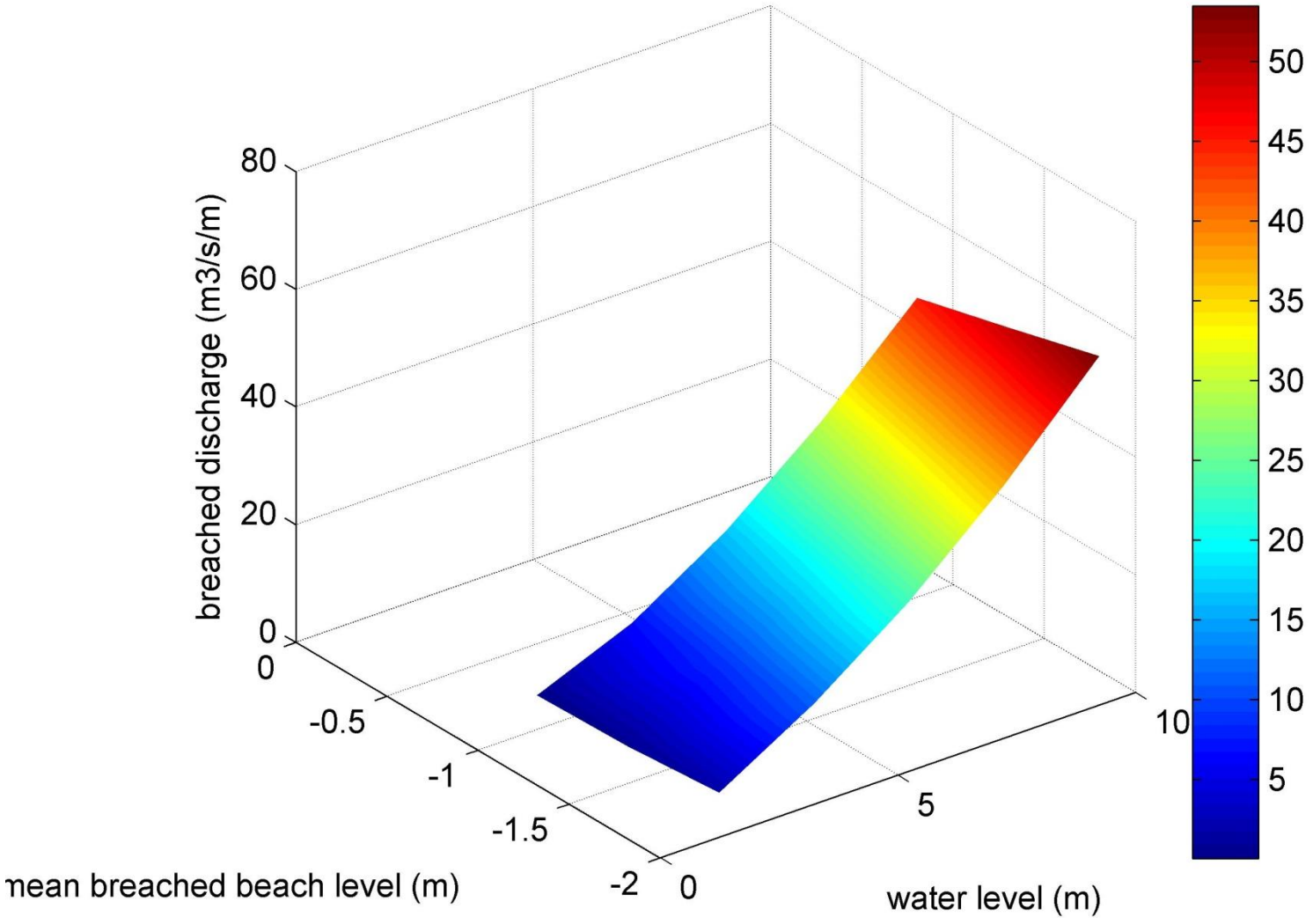
E-scenario4, M-ALL Fig 1.28CP.opj

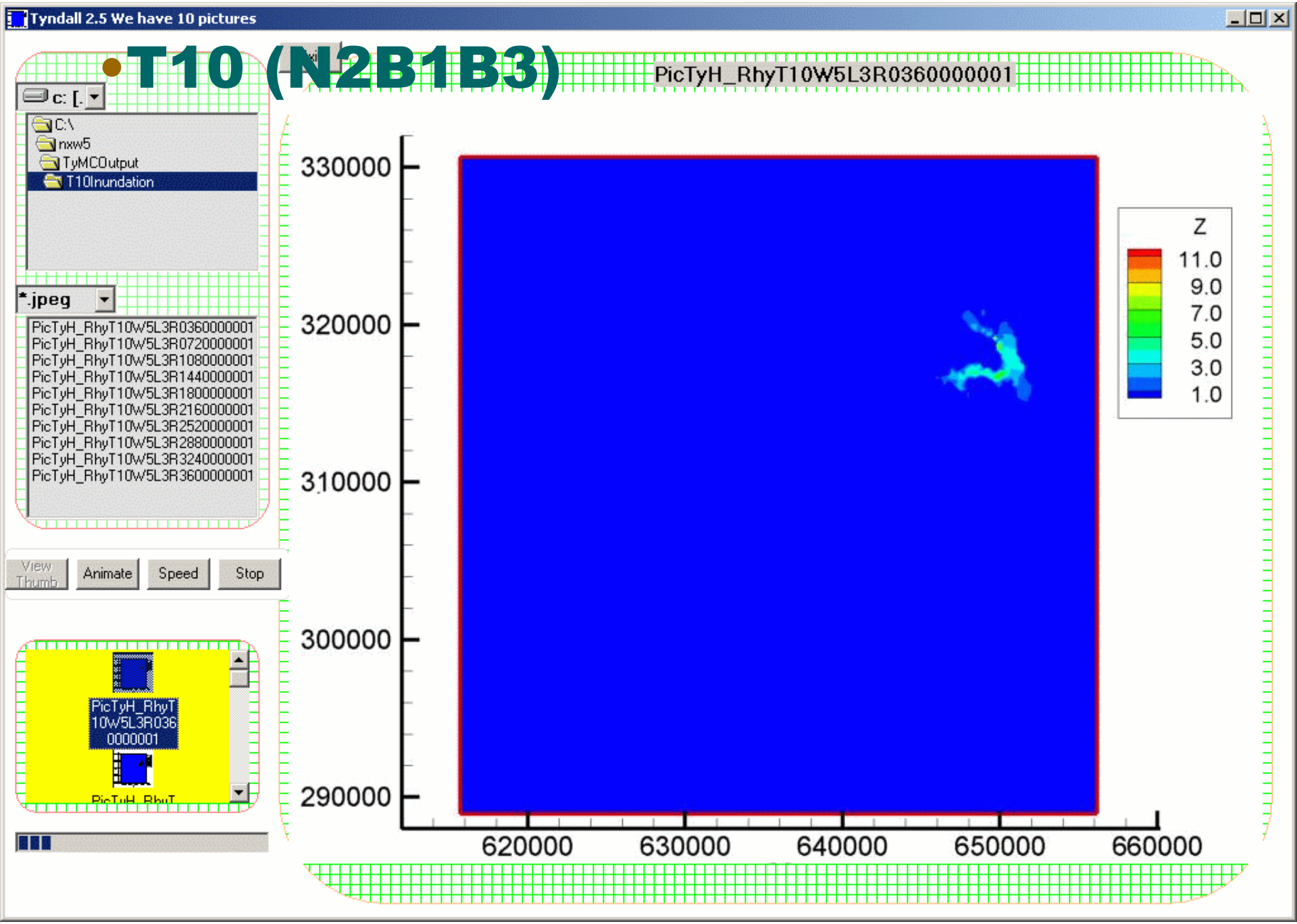
Flood defence breaching





Typical breach discharge




Tyndall 2.5 We have 10 pictures
T10 (N2B1B3)
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c: [.
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TyMCOutput
T10Inundation
*.jpeg
PicTyH_RhyT10W5L3R0360000001
PicTyH_RhyT10W5L3R0720000001
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View Thumb
Animate
Speed
Stop
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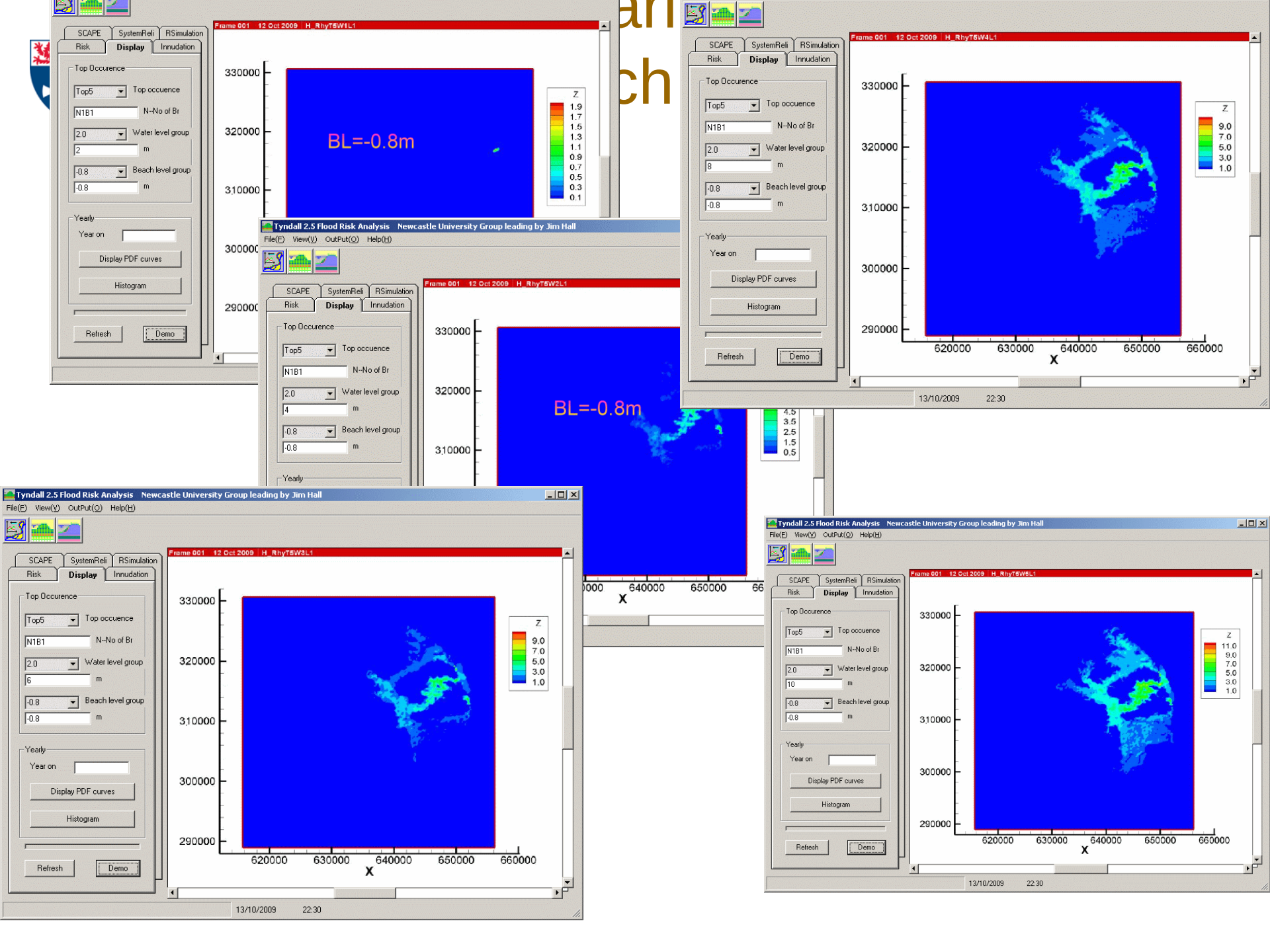
1.0


Tyndall 2.5 Flood Risk Analysis Newcastle University Group leading by Jim Hall
File(F) View(V) OutPut(O) Help(H)
SCAPE SystemReli RSimulation
Risk Display Innudation
Top Occurence
Top5 Top occuence
N1B1 N-No of Br
2.0 Water level group
2 m
-0.8 Beach level group
-0.8 m
Yearly
Year on
Display PDF curves
Histogram
Refresh Demo
Frame 001 12 Oct 2009 H_RhyT5W1L1
BL=-0.8m
Frame 001 12 Oct 2009 H_RhyT5W2L1
BL=-0.8m
4 m
Frame 001 12 Oct 2009 H_RhyT5W3L1
6 m
Frame 001 12 Oct 2009 H_RhyT5W4L1
8 m
Frame 001 12 Oct 2009 H_RhyT5W5L1
10 m
330000
320000
310000
300000
290000
620000 630000 640000 650000 660000
X
Z
13/10/2009 22:30

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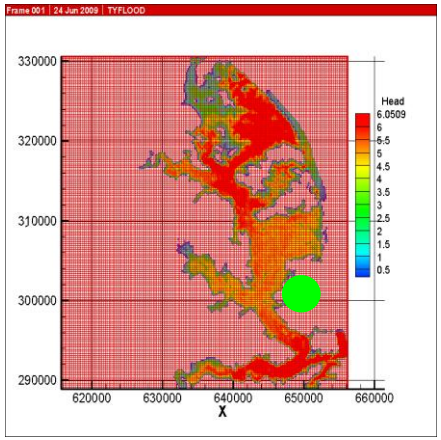
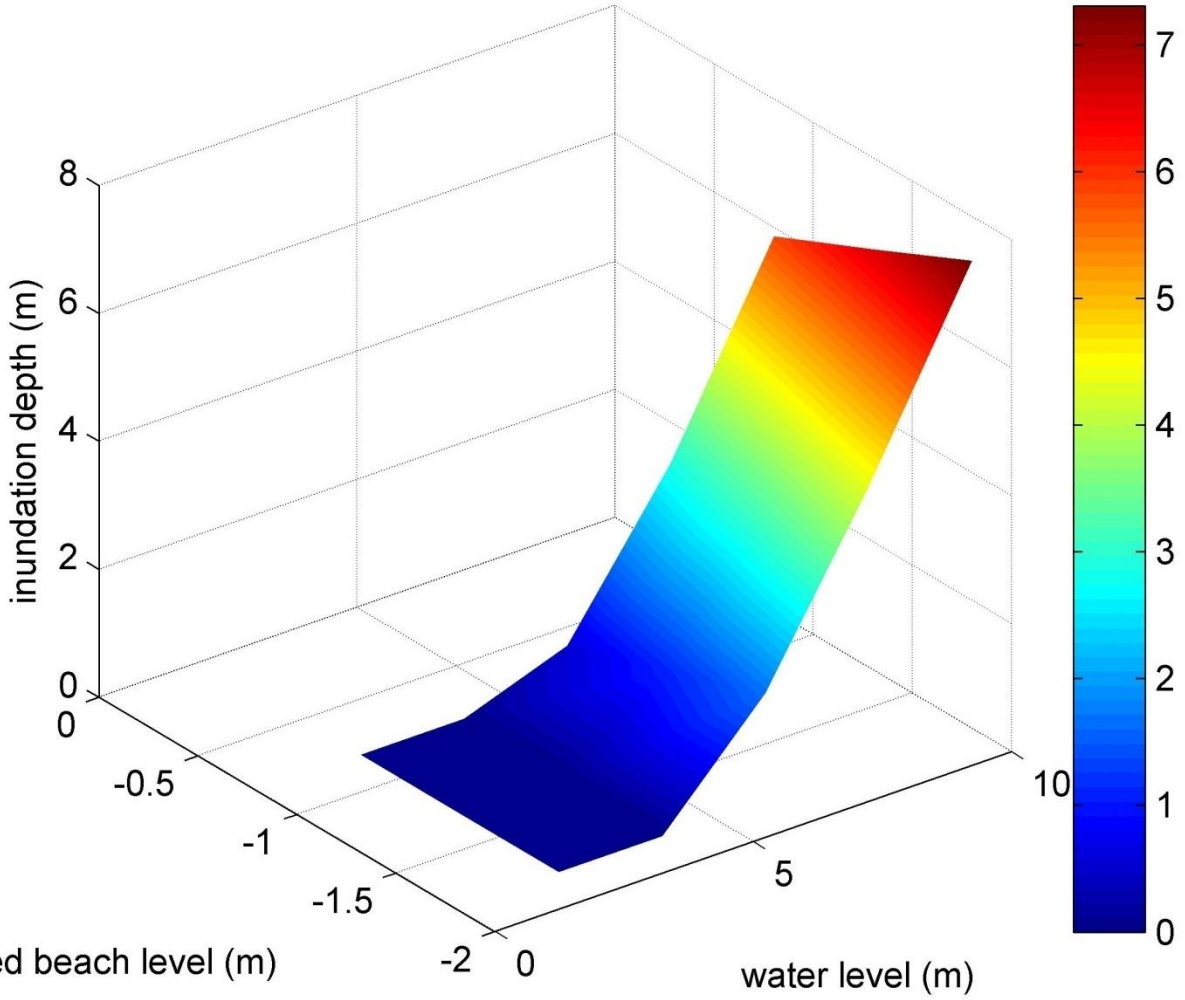
Typical flood depth





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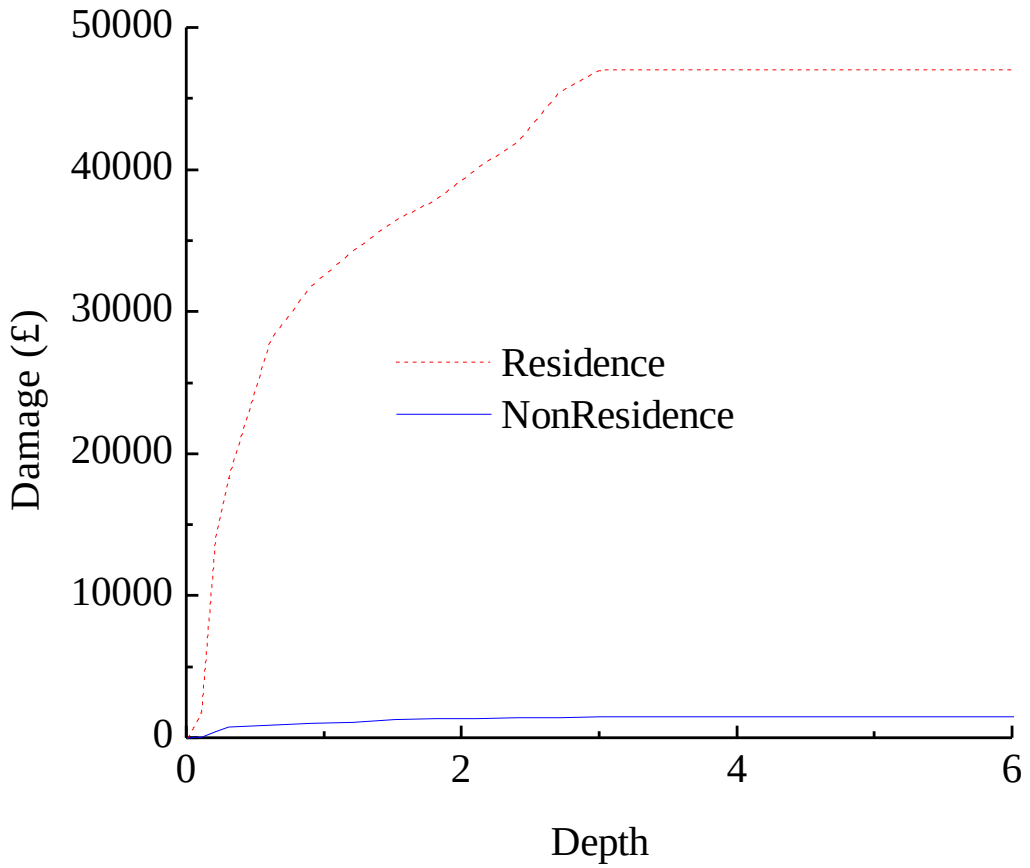
Depth damage curve



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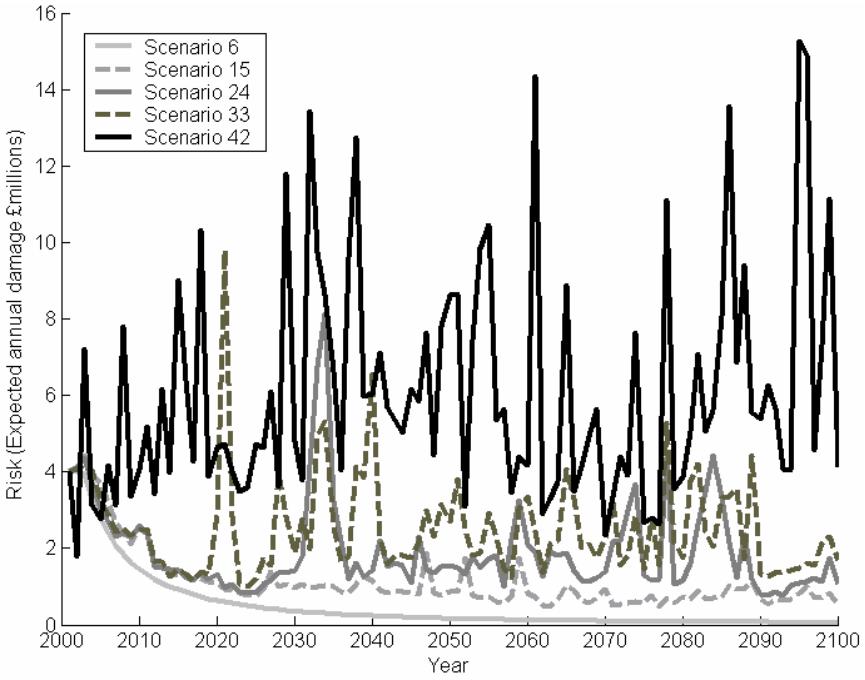
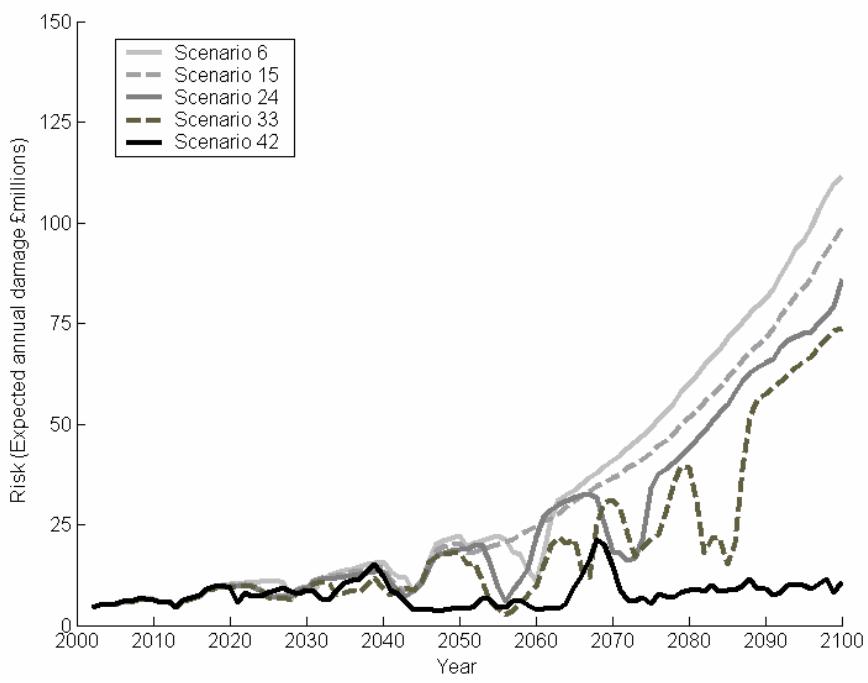
Phase 1 results

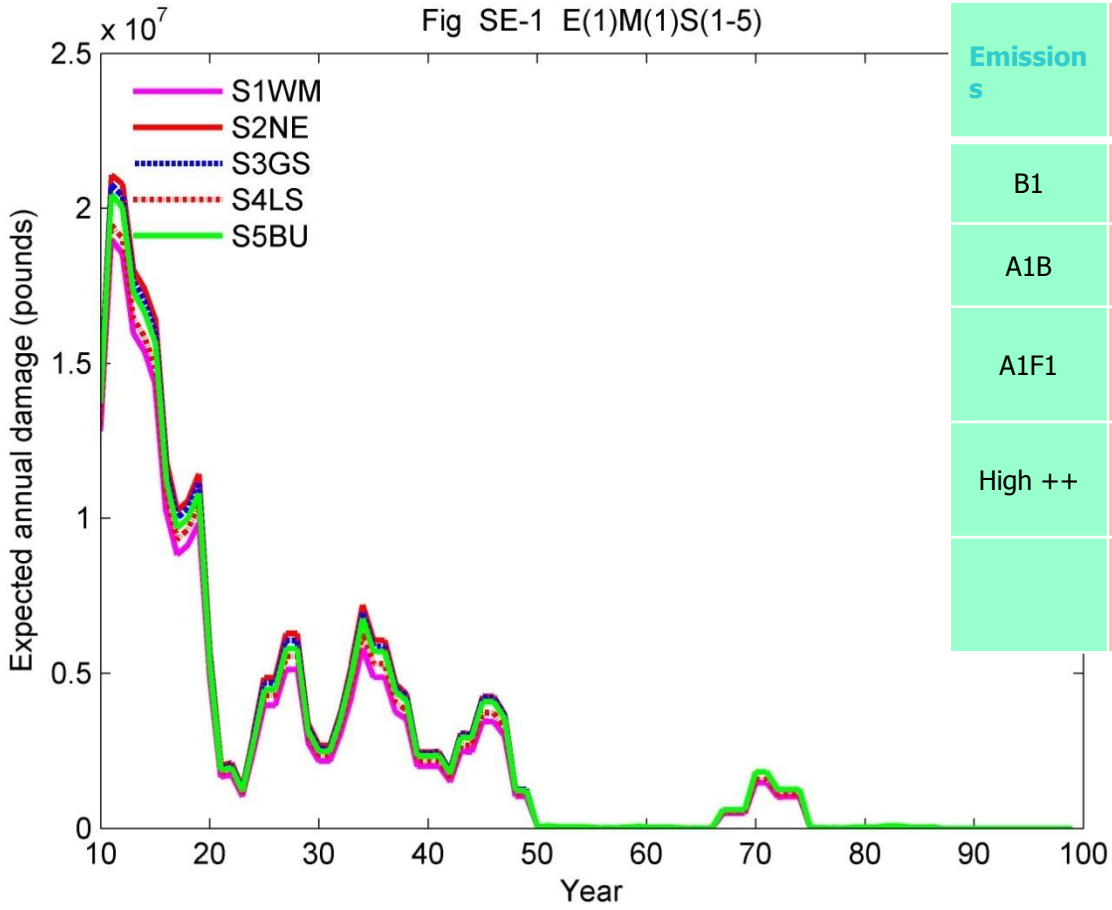


Erosion risk to 2100



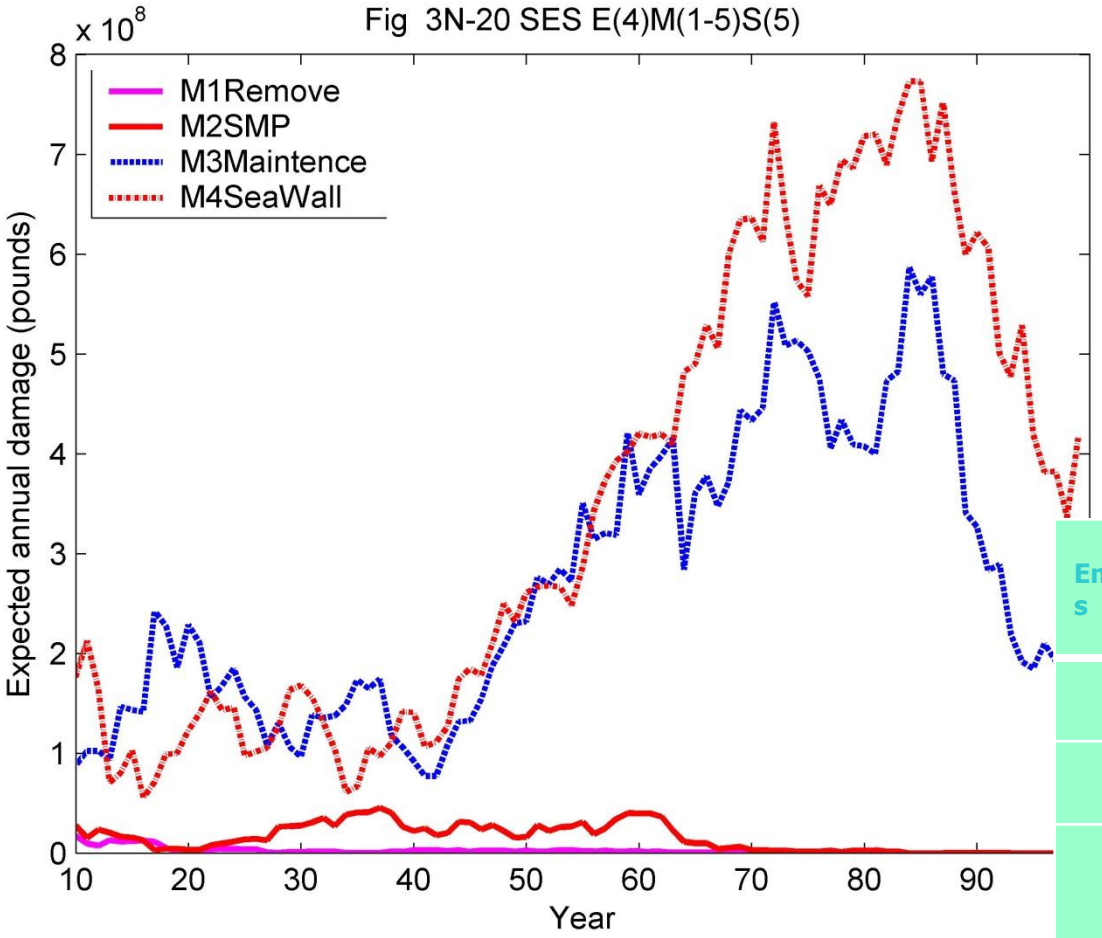
Flood risk to 2100

New flood risk results



Emissions	Management	Measures	Socio-economic
B1	M1	Removal of all defences	World Markets
A1B	M2	'SMP'	National Enterprise
A1F1	M3	Maintain existing defences	Global Sustainability
High ++	M4	Construct seawalls everywhere	Local Stewardship
	M5	The 'SMP', without beach nourishment	Business as Usual

Flood risk



Emissions	Management	Measures	Socio-economic
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A1B	M2	'SMP'	National Enterprise
A1F1	M3	Maintain existing defences	Global Sustainability
High ++	M4	Construct seawalls everywhere	Local Stewardship
	M5	The 'SMP', without beach nourishment	Business as Usual

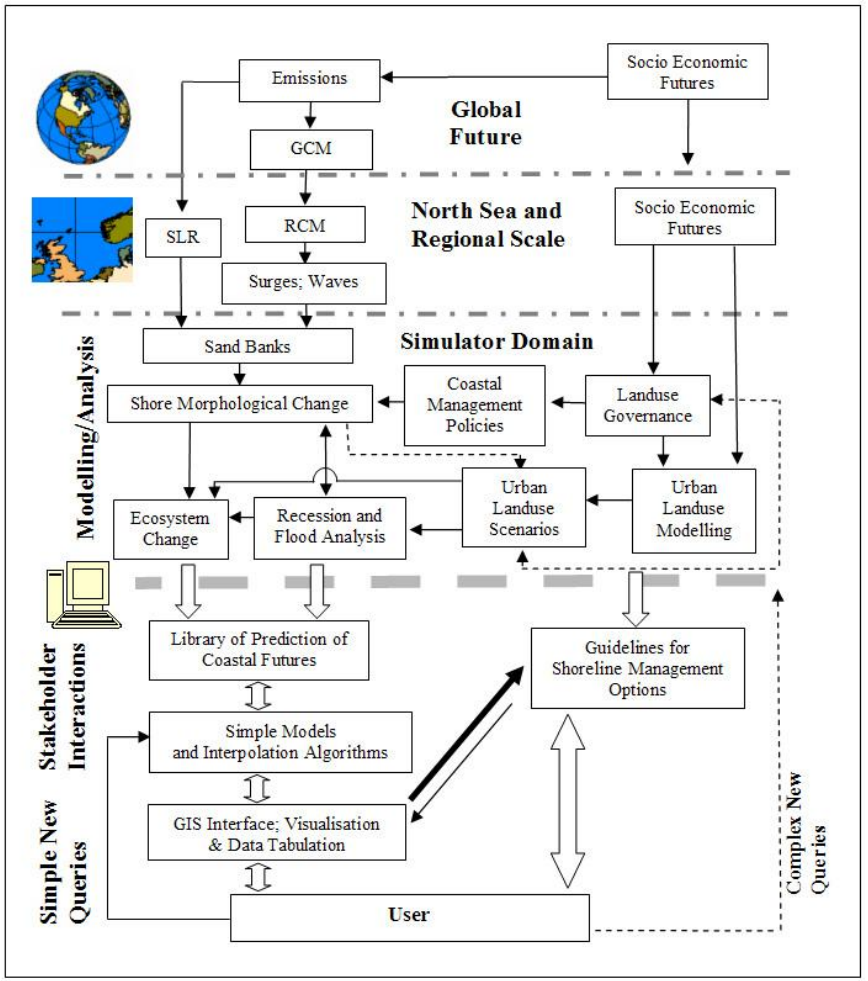
Conclusion

The Coastal Cimulator accounts for the interactions between coastal erosion AND flood risk

- on a broad spatial scale
- over extended timescales.

Uncertainties in sea level rise and model internal variability are sampled to give probabilistic predictions of

- cliff top recession
- beach volume
- dike failure
- flood risk
- socio-economic scenarios



Questions: What are the likely management options for the Happisbugh to Winterton coast?