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Outstanding Student & PhD candidate Presentation contest

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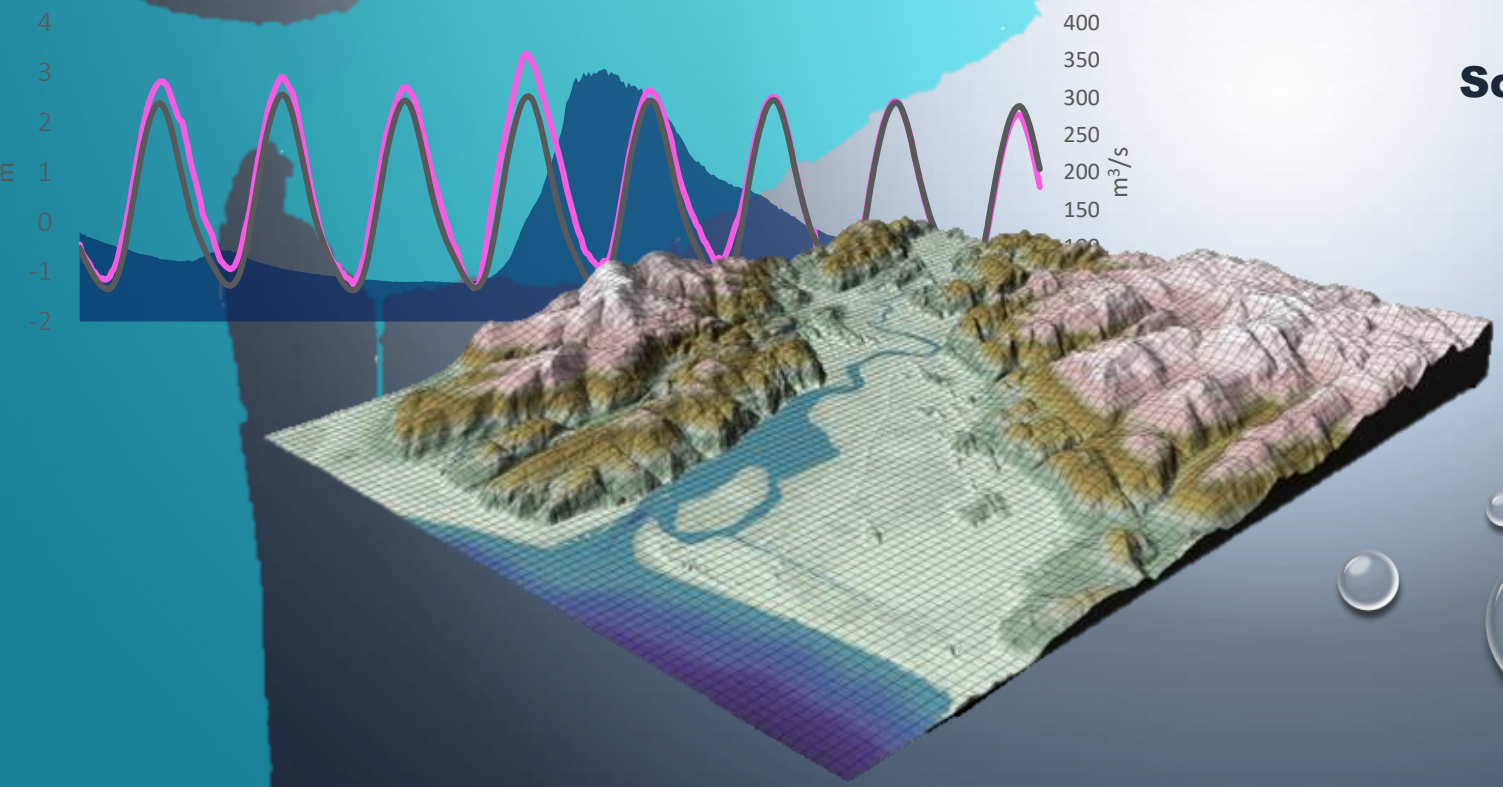
The importance of estuary shape in evaluating the flood risk in estuaries

Mirko Barada, Dr. Peter Robins,
Dr. Matthew Lewis, Dr. Martin Skov
School Of Ocean Sciences, Bangor University



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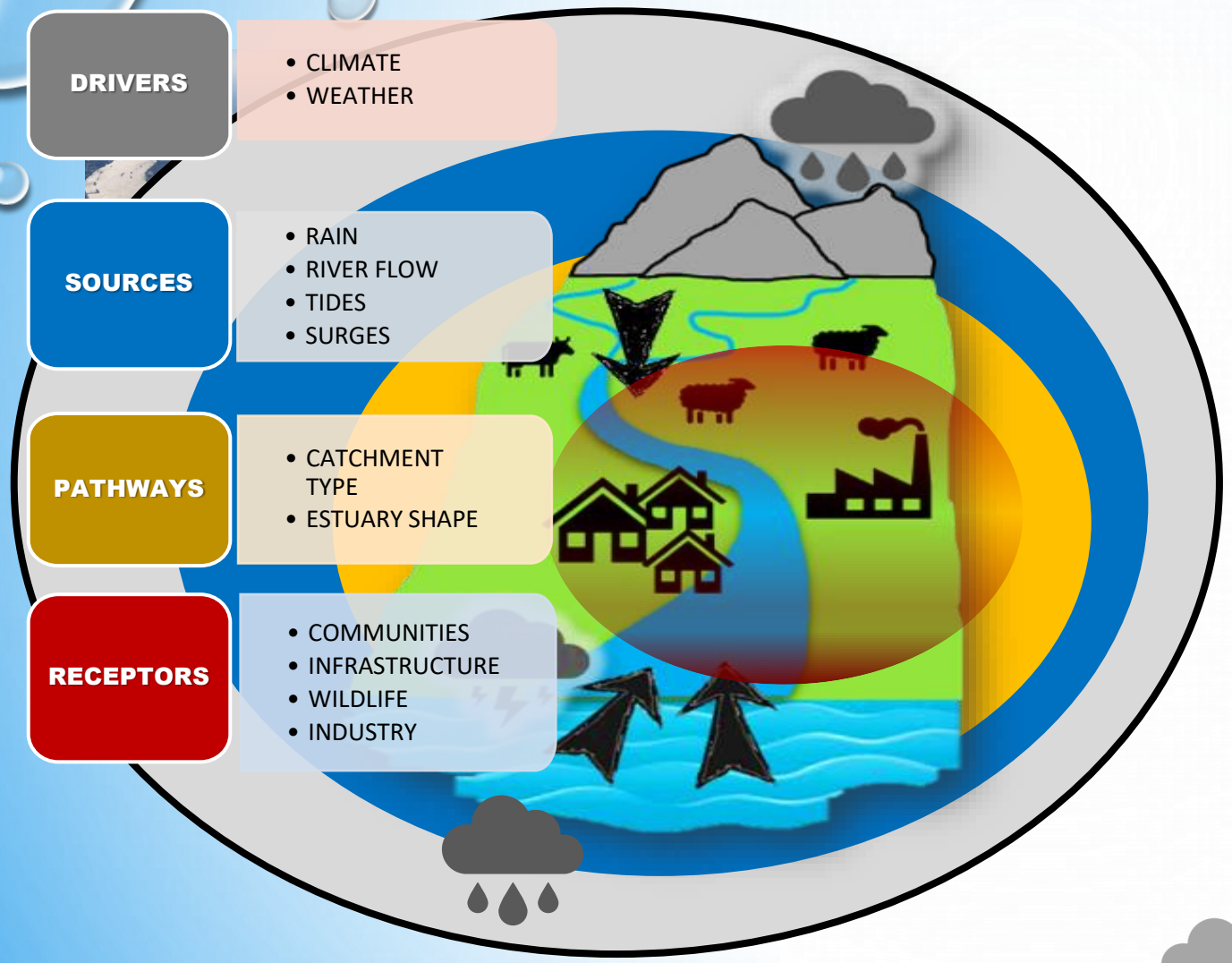
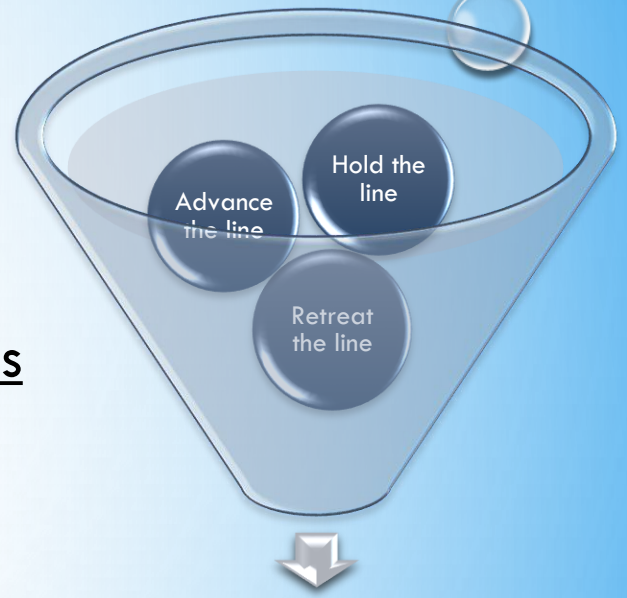


INTRODUCTION

- ESTUARIES
  - areas of great biodiversity
  - traditionally highly populated areas
  - vulnerable to different hazards, such as (compound) flooding

OBJECTIVES AND HYPOTHESIS



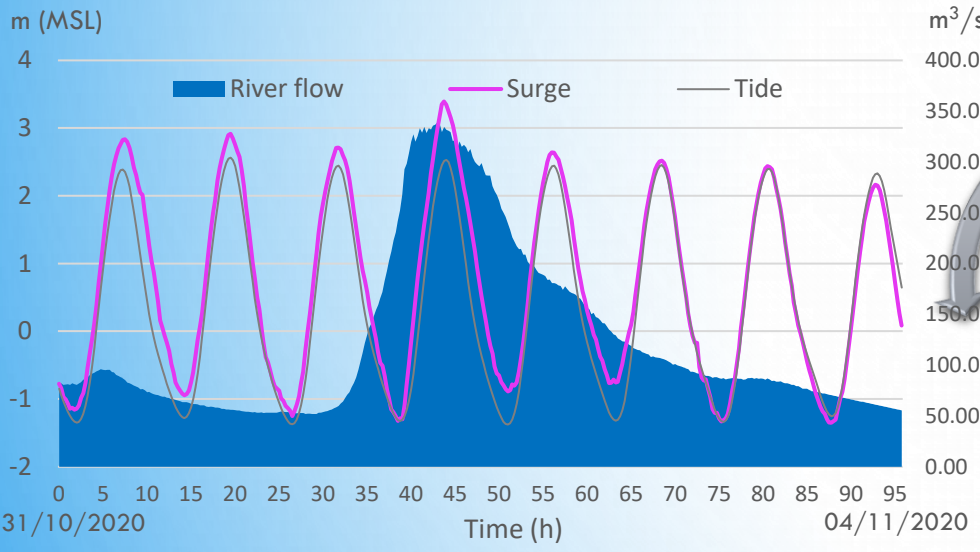
- Objectives of the research:
  - How sensitive is compound flooding to different estuary shapes **today ?**
    - Different management scenarios, different historical stage of the estuary, idealized estuaries
  - **In the future ?**
    - Applying UKCP18 projections for SLR and river flow increase

- Main hypothesis
  - *Changes in flood pathways have larger effect on flood risk in estuaries than changes in flood drivers or sources itself*

METHODOLOGY

1 BOUNDARY CONDITIONS

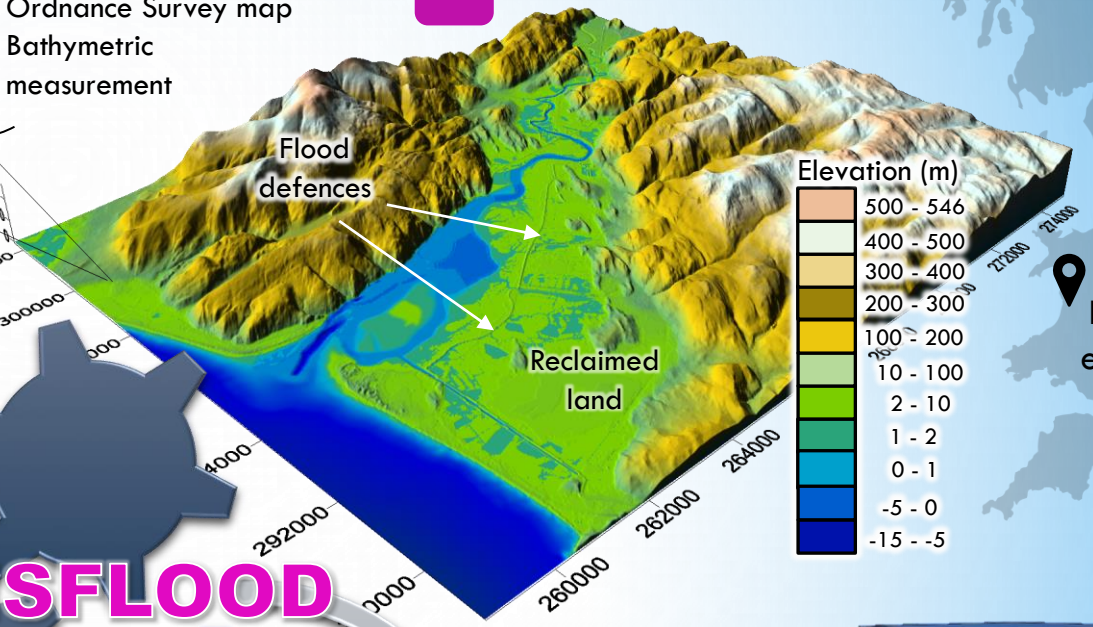
- Time varying water levels (m, MSL) forced from the coast (data from Barmouth station, ~ 40 km)
- River discharge (in m^3/s), forced from the Dyfi bridge

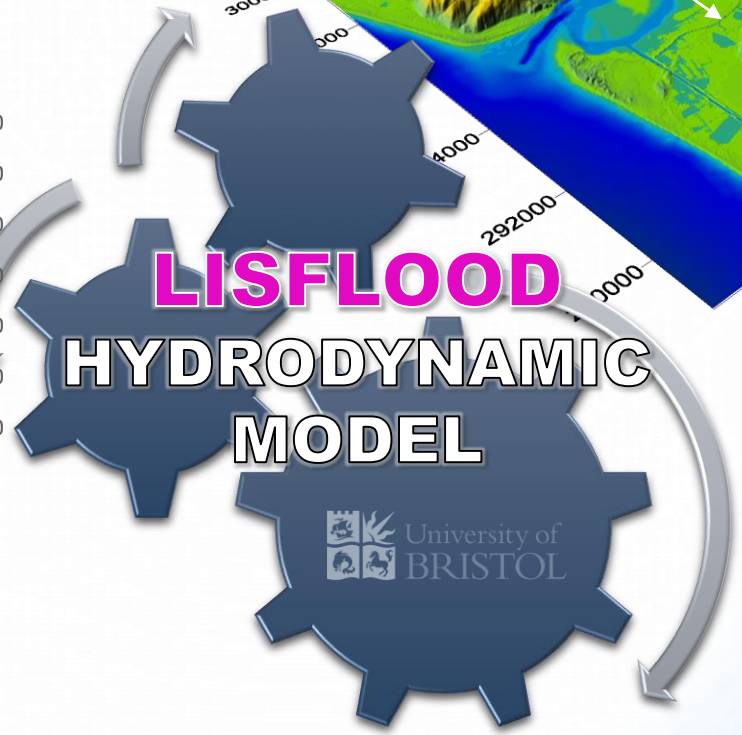


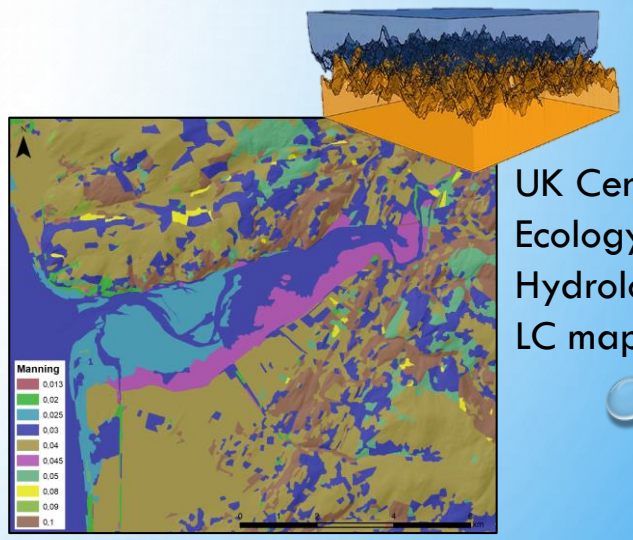
2 DIGITAL ELEVATION MODEL

- LiDAR
- Ordnance Survey map
- Bathymetric measurement

20 m
20 m







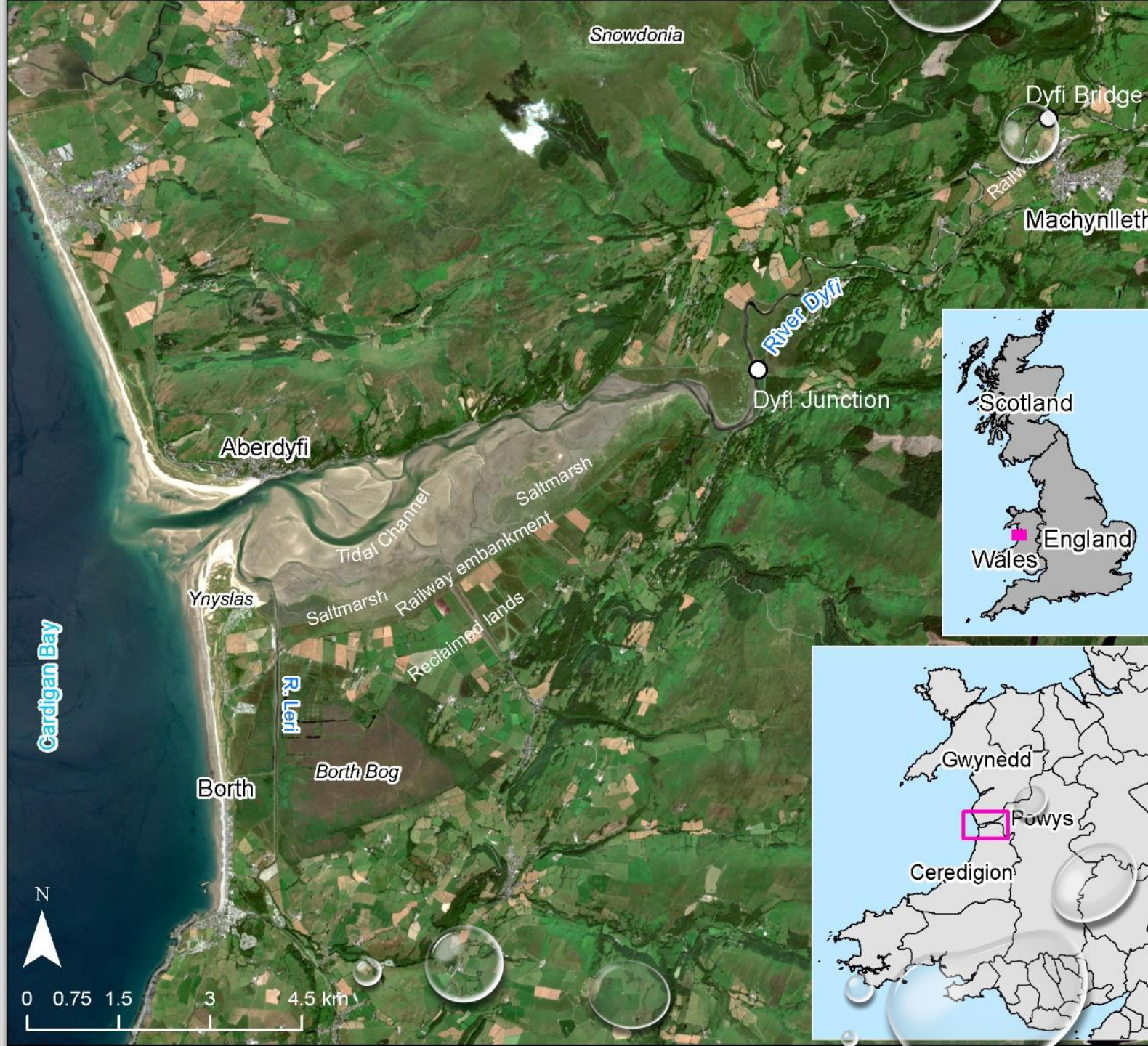
UK Centre for Ecology and Hydrology LC map 2019

3 ROUGHNESS COEFFICIENT

- Manning's n

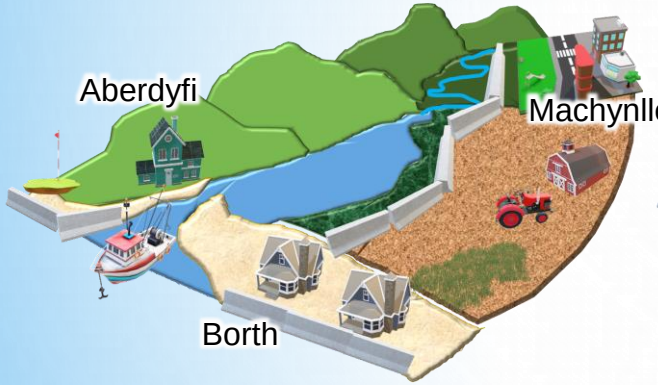
DYFI ESTUARY

- Mid-Welsh fast-response estuary
- Semi enclosed; bar built
- Afon Dyfi max. flow (1979): 403,5 m^3/s
- largest storm surge (1997): 1,476 m



DIFFERENT ESTUARY SHAPES

HOLD THE LINE



FLOODPLAIN RESTORATION

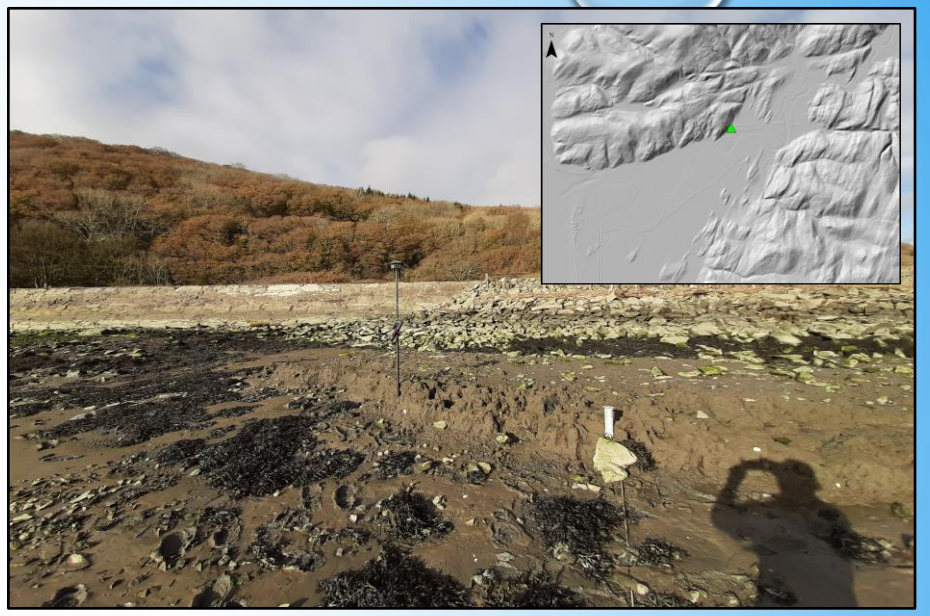
ADVANCE THE LINE

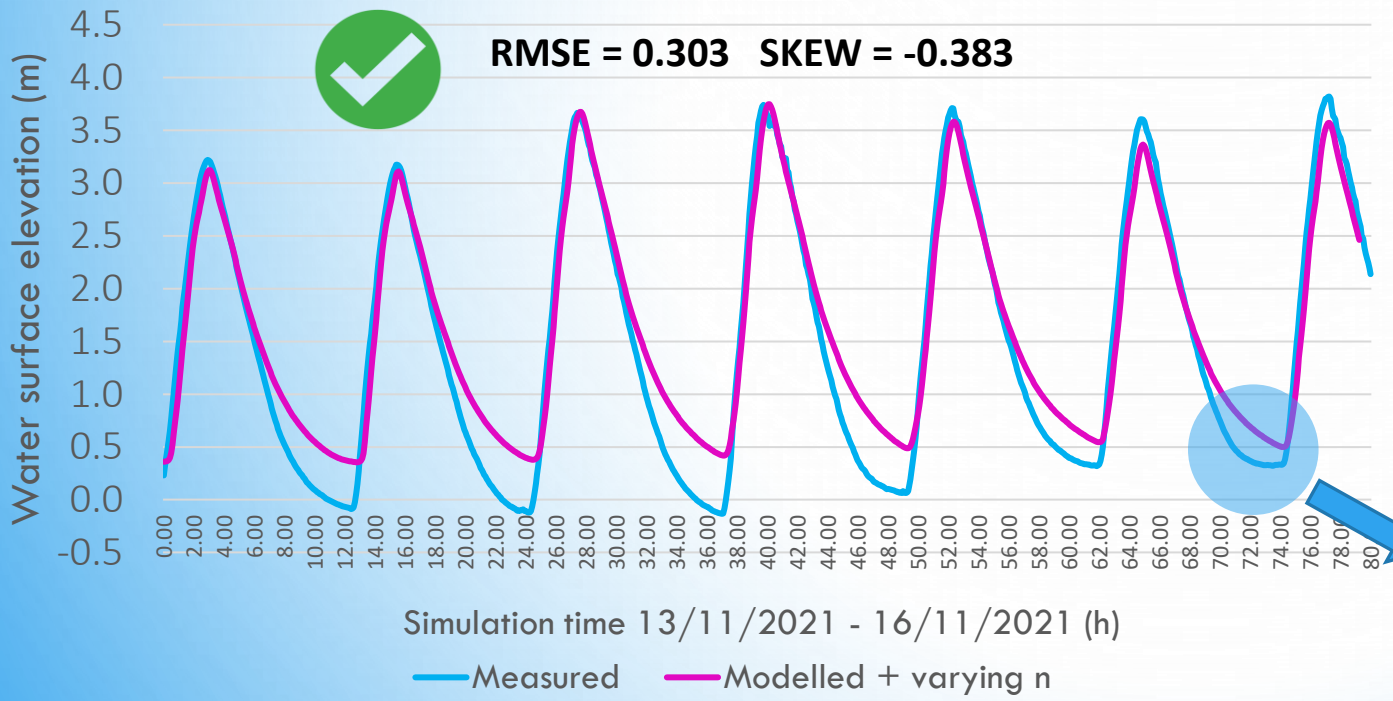
RETREAT THE LINE

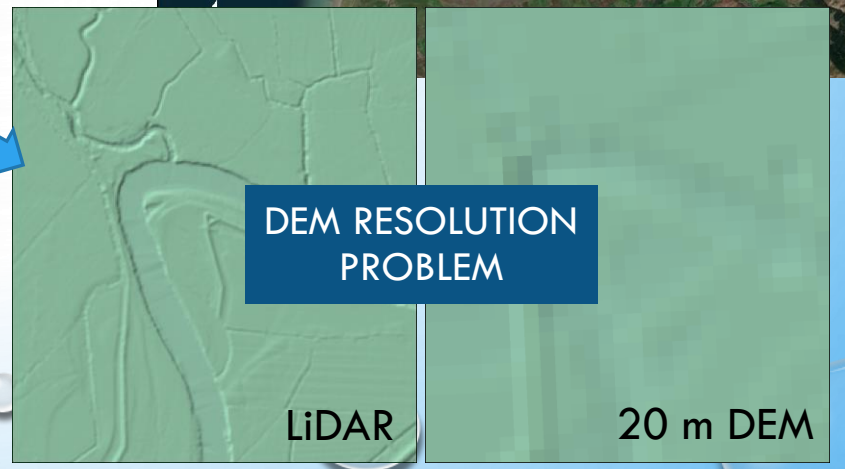
BREACH IN THE LINE

WIDER ENTRANCE

MODEL VALIDATION



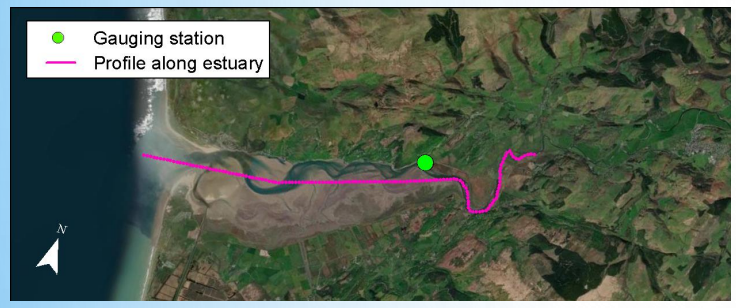


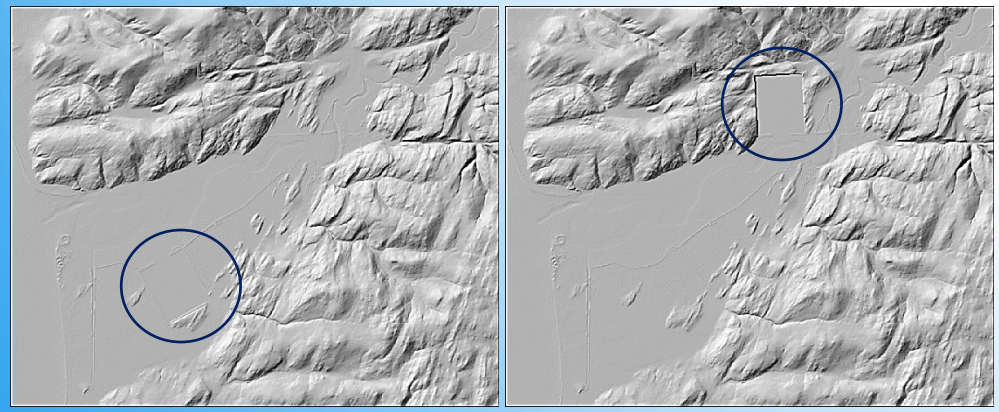


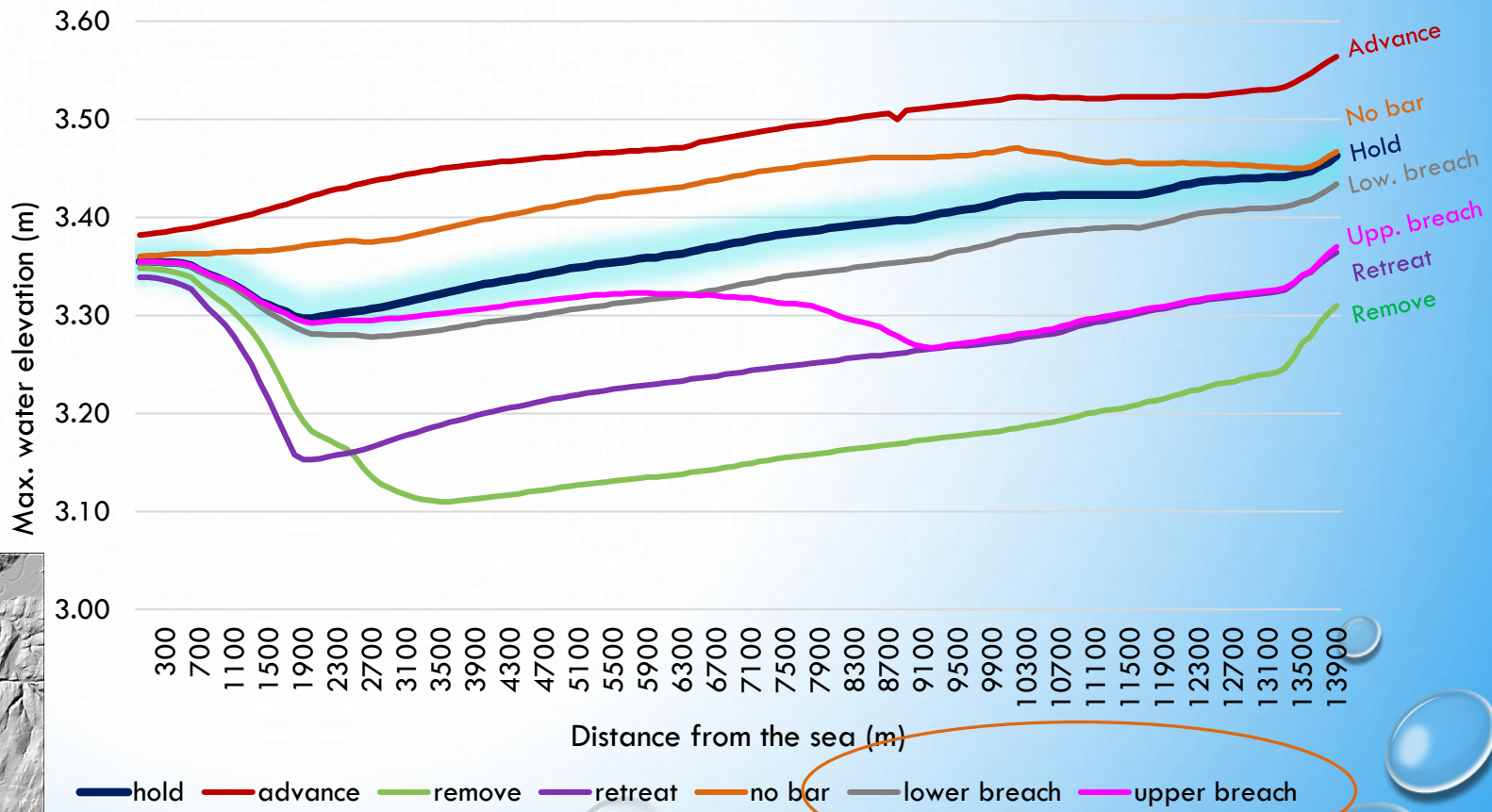
MAXIMUM WATER SURFACE ELEVATION ALONG ESTUARY

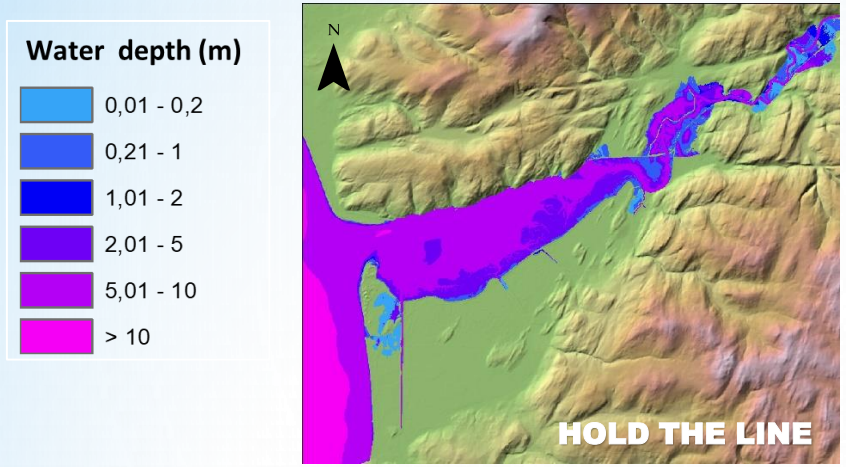
=

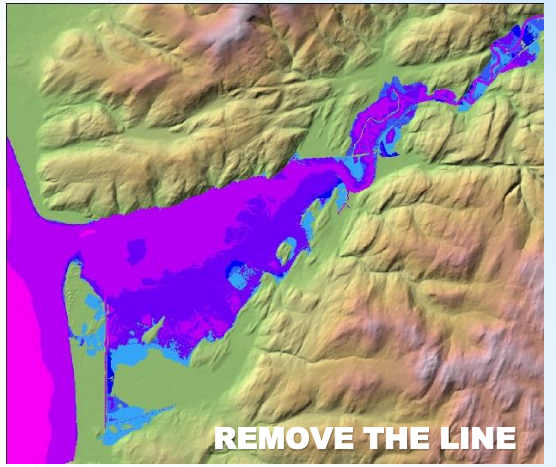
Main indicator of flood risk in this research

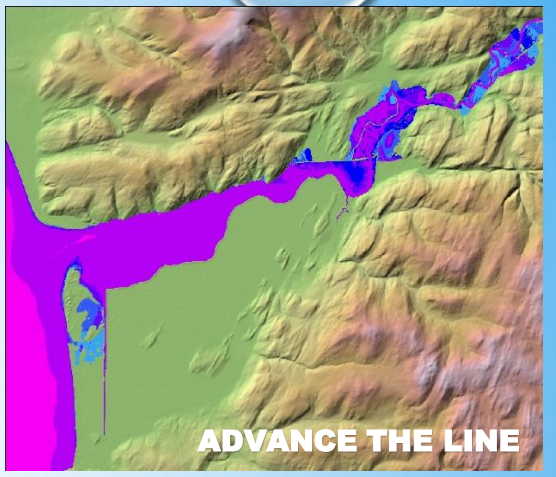


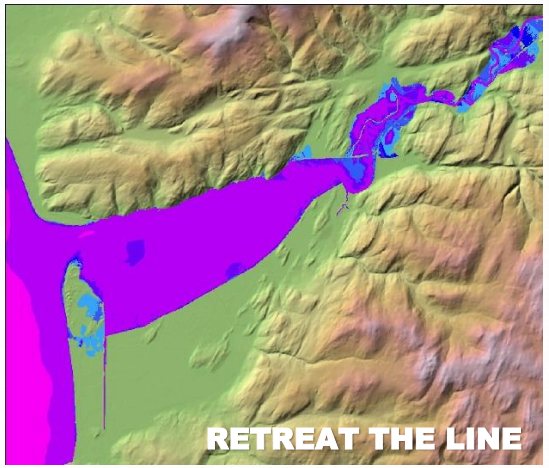


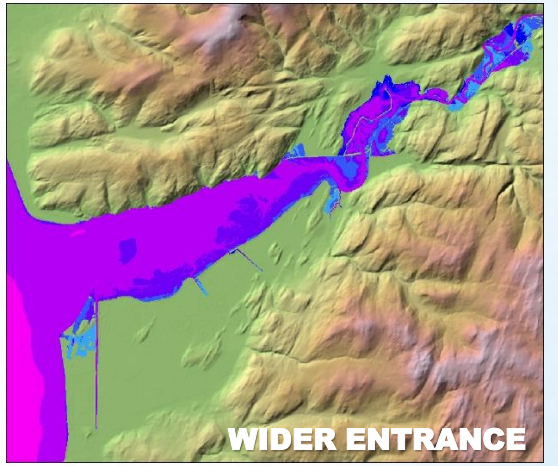


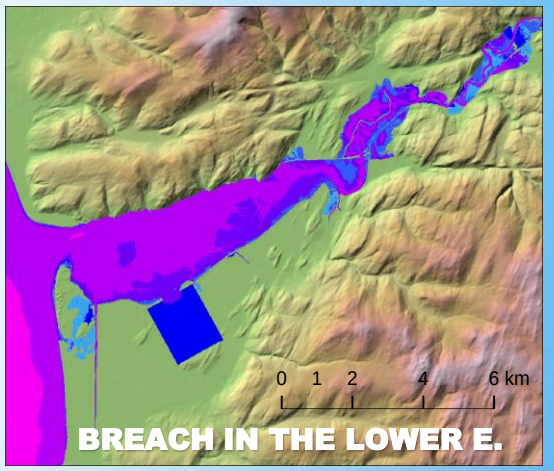


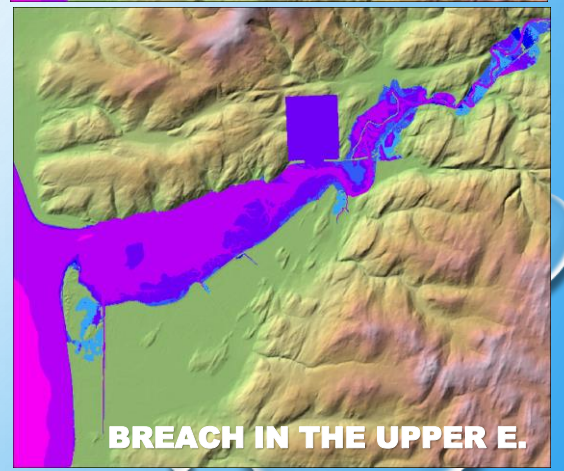












	Volume (m^3)	Area (m^2)
hold	199,090,000.00	38,950,000.00
remove	205,020,000.00	48,462,000.00
advance	217,610,000.00	33,138,000.00
retreat	210,430,000.00	41,950,000.00
no spit	209,680,000.00	40,398,000.00
breach (mean)	201,410,000.00	43,073,000.00

IS ESTUARY SHAPE MORE IMPORTANT THAN FLOOD BEHAVIOUR ?

EXPECTED INCREASE IN FLOODING

TIMING	INTENSITY (climate change)		ESTUARY SHAPE
Relative timing of flood peaks (+/-)	**SLR**	**River flow increase**	**Management scenarios**
10 h	0.25 m	10%	Remove the line
8 h	1 m	40%	Breach in the lower estuary
6 h			Breach in the upper estuary
4 h			Retreat the line
0 h			Hold the line
			Wider entrance
			Advance the line

DESIGN STORMS

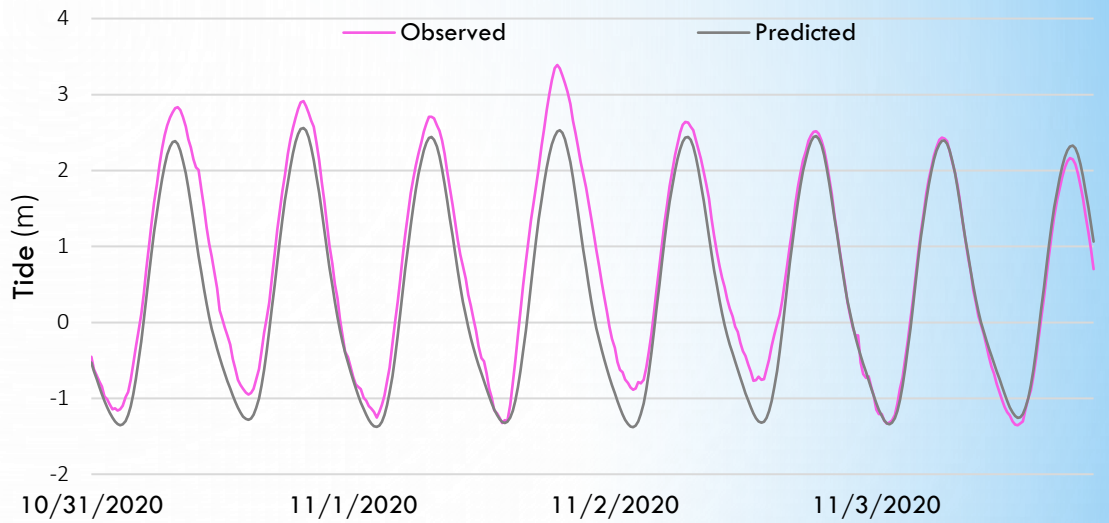
All combined with present-day estuary shape only

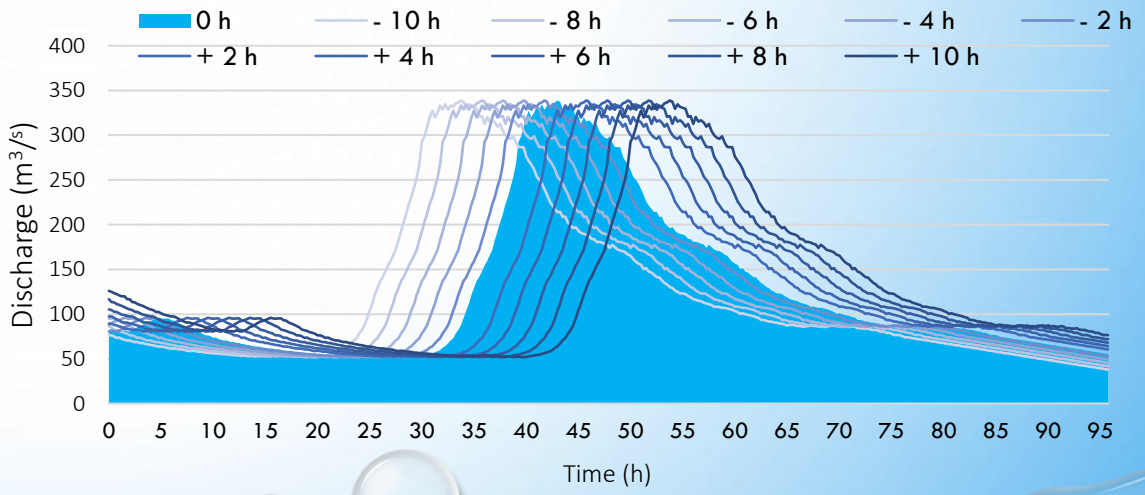
All combined with uniform present-day extreme compound event

1. RELATIVE TIMING (RT) SENSITIVITY TEST

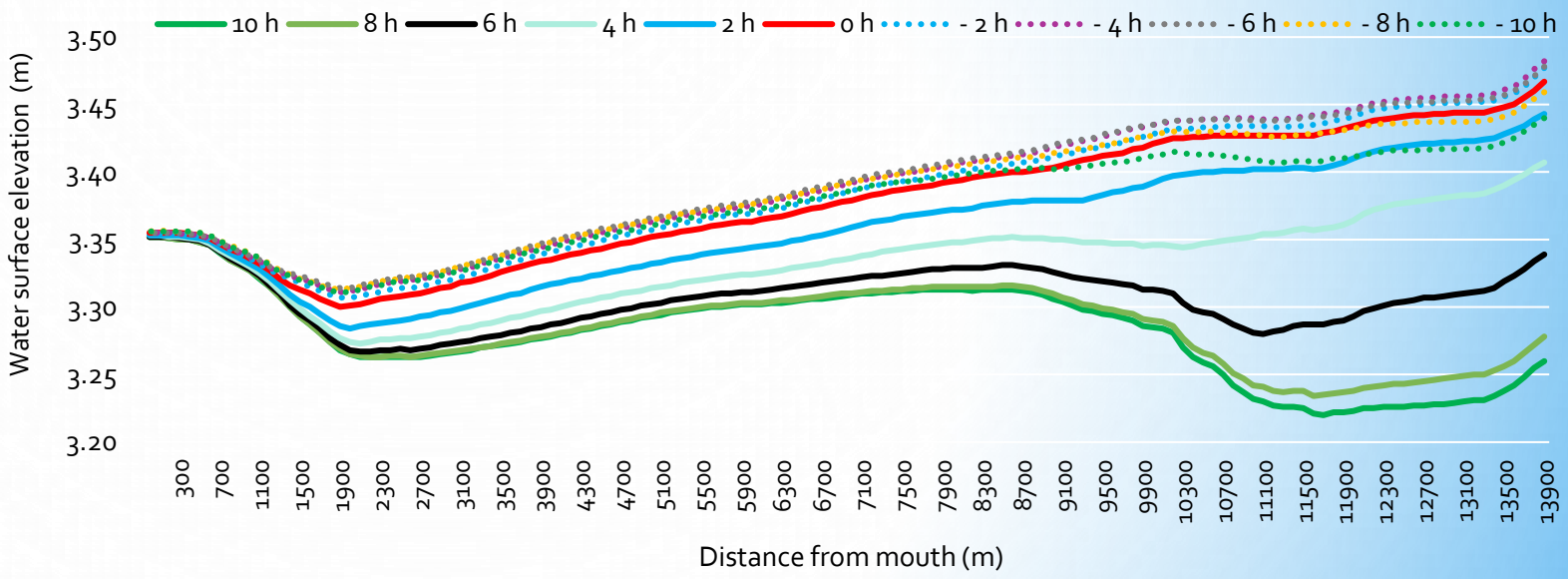
- Relative timings between peak high water and peak flow

- Using +/- 2 h intervals
  - Up to +/- 10 h in total





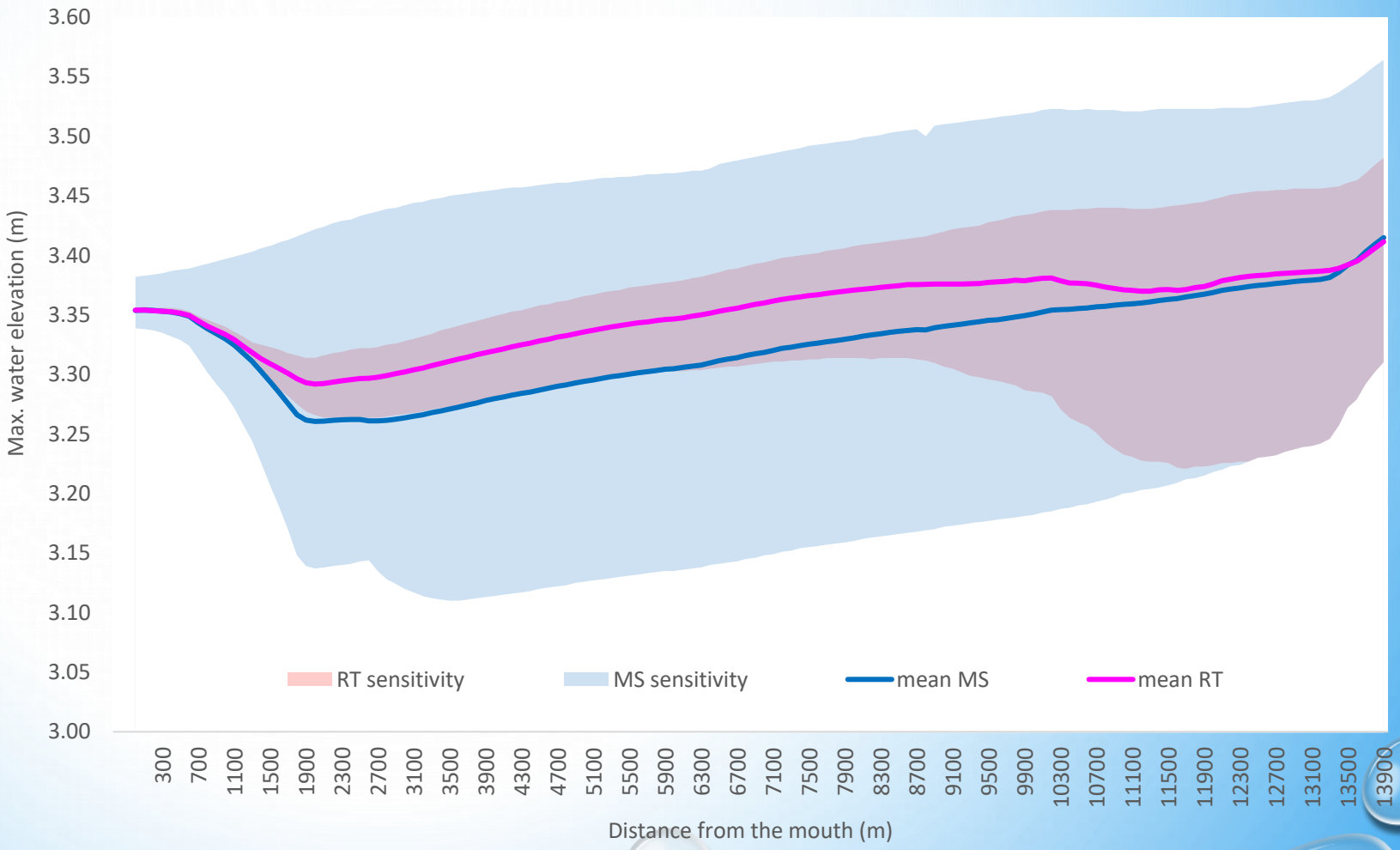
1. RELATIVE TIMING (RT) SENSITIVITY TEST



1. RELATIVE TIMING (RT) SENSITIVITY TEST

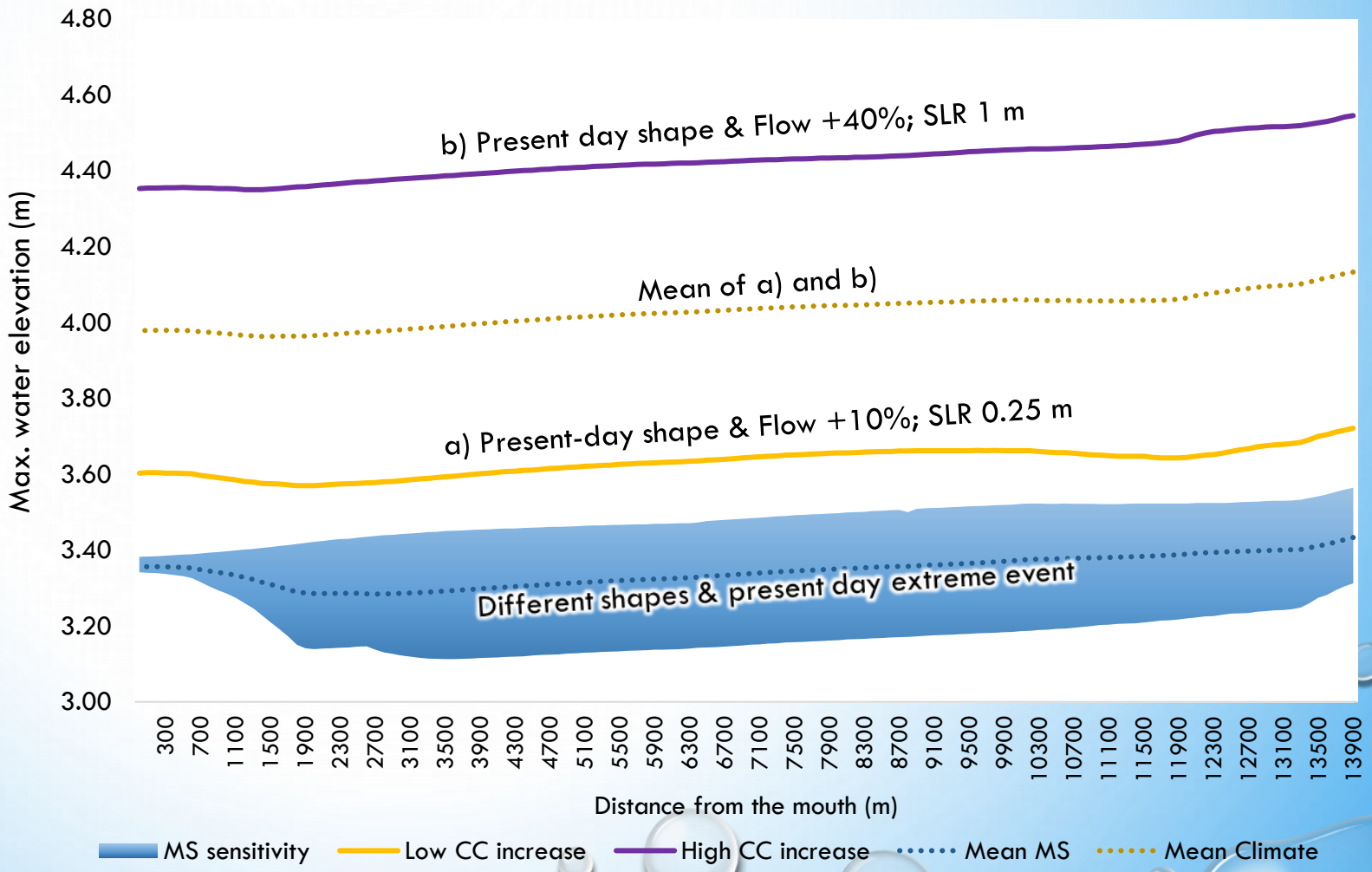
- Variability lower than one produced by different estuary shapes
  - Mean water elevation higher for RTs

- Estuary shape has larger control on flooding than relative timing of flood peaks



2. CLIMATE CHANGE (CC) SENSITIVITY TEST

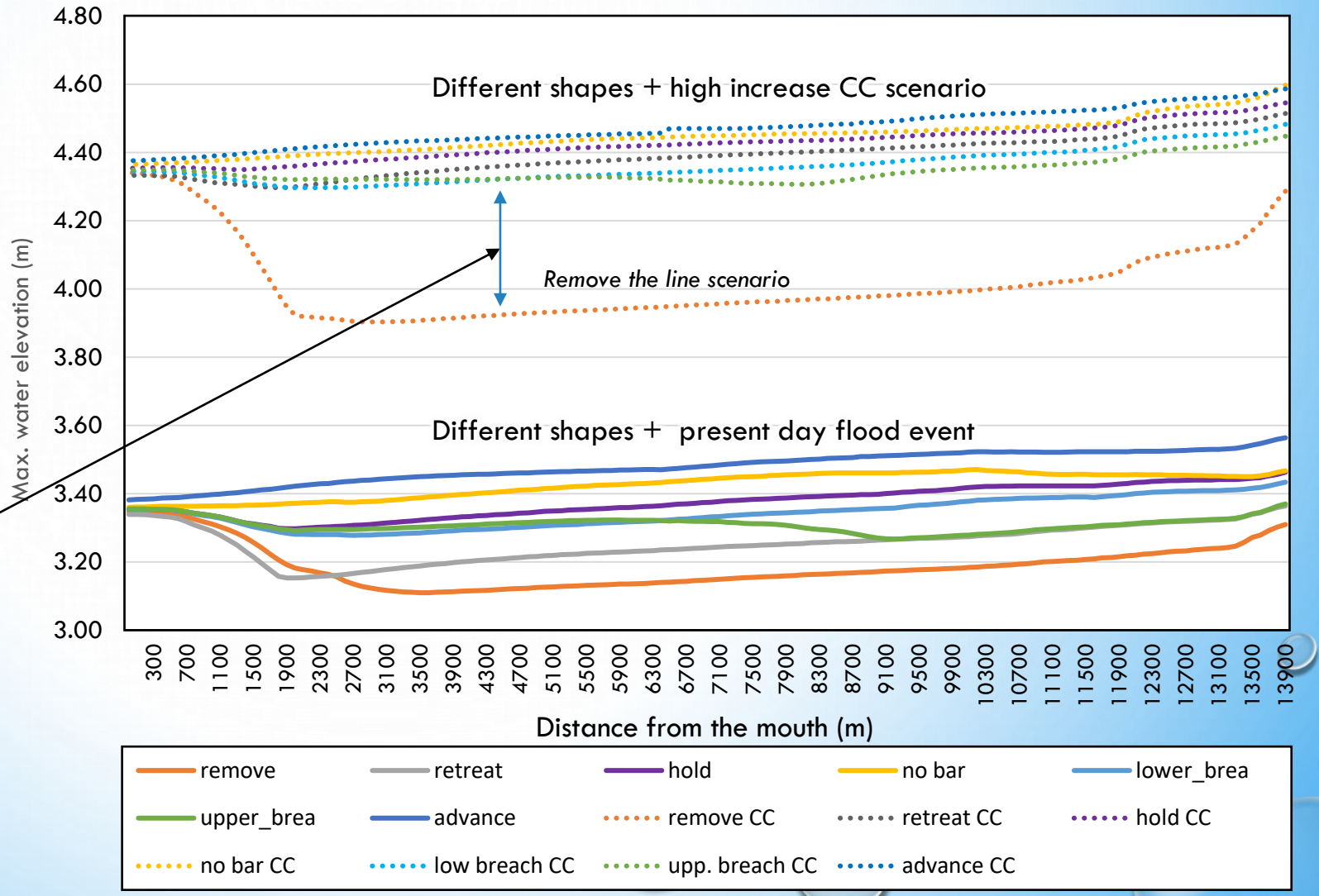
- Climate change much bigger threat to flooding than any management scenario
- Much bigger total volume of water



2. CLIMATE CHANGE (CC) SENSITIVITY TEST

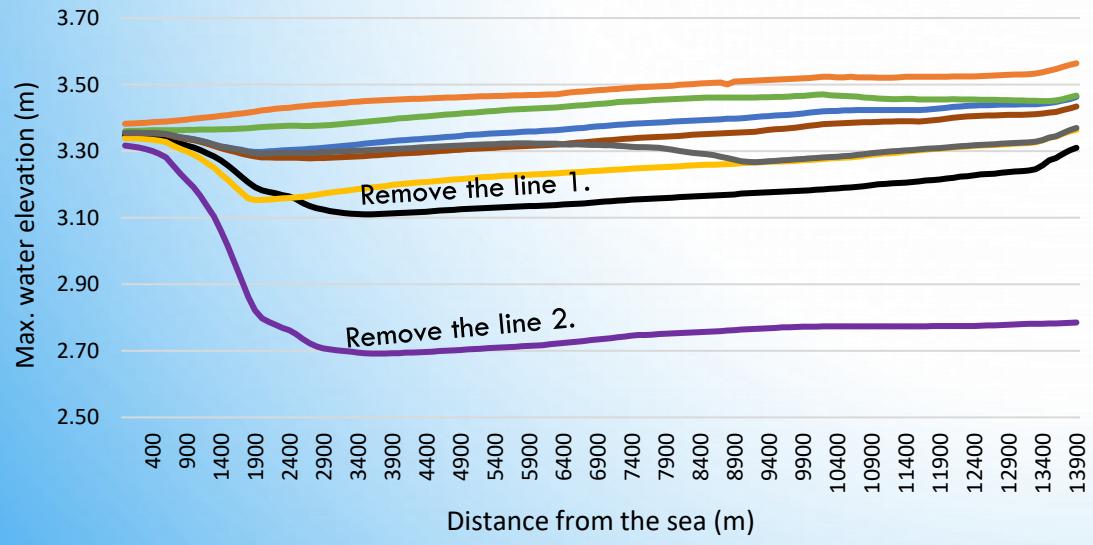
- Smaller variability in water elevations for the future projections

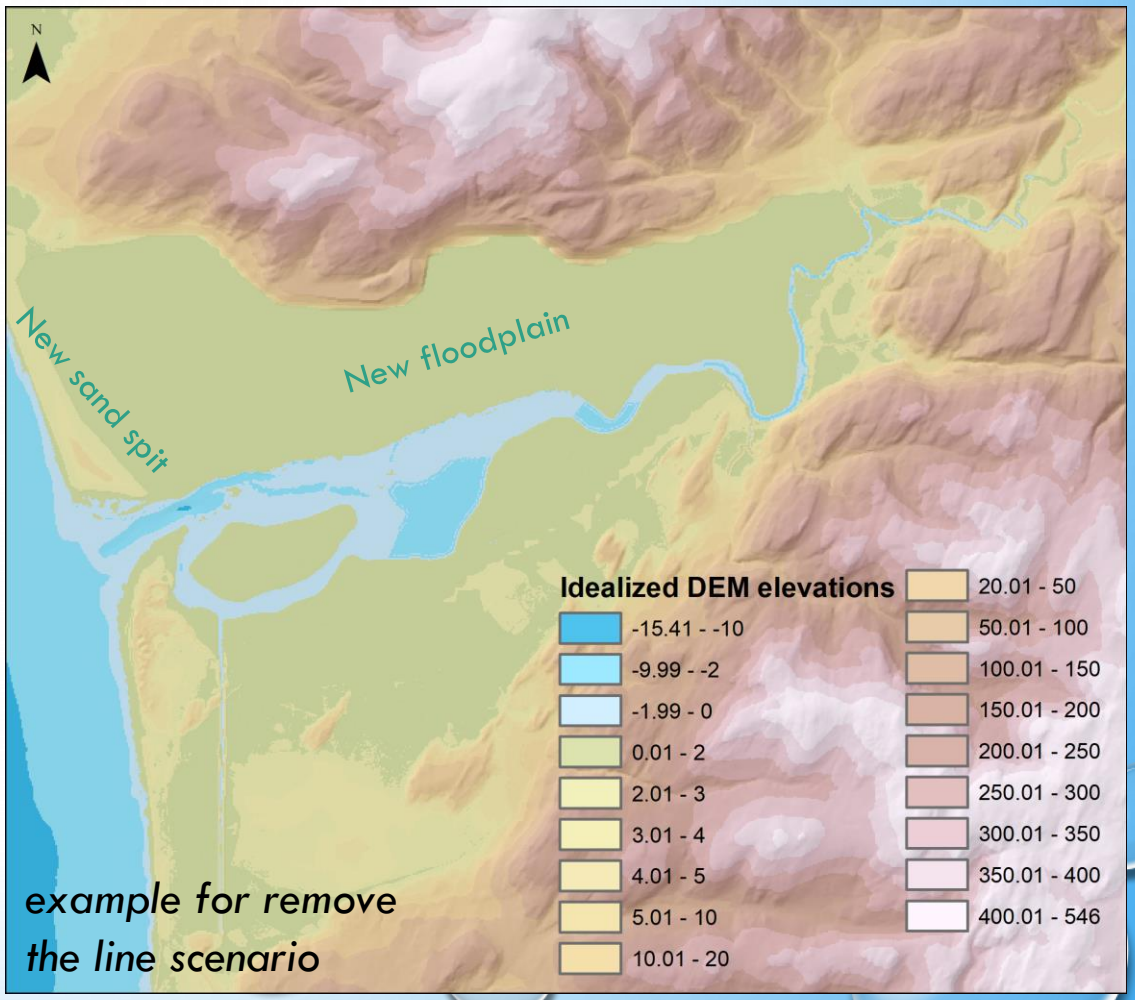
- Estuary shape becoming less important
  - Except in floodplain restoration scenario



NEXT STEPS AND FINAL STAGE

- Will the same patterns occur in a larger and more different estuary ?
  - "Idealizing" the existing bathymetry to find the answer





SUMMARY AND CONCLUSIONS

- Different **management scenarios/estuary shapes → large impact** on flood risk
  - important "where" the intervention happened
- Estuary shape is having larger control on flooding than flow-surge relative timing
- **Climate change** has the biggest impact among all parameters
  - **Total volume of water** far more important than management solutions
  - Only **nature-based** and restoration-focused measures can mitigate future flood risk

THANK YOU

Mirko Barada, PhD student
mirko.barada@bangor.ac.uk
School of Ocean Sciences
Bangor University

PRIFYSGOL BANGOR UNIVERSITY

@MirkoBarada