



HR Wallingford
Working with water

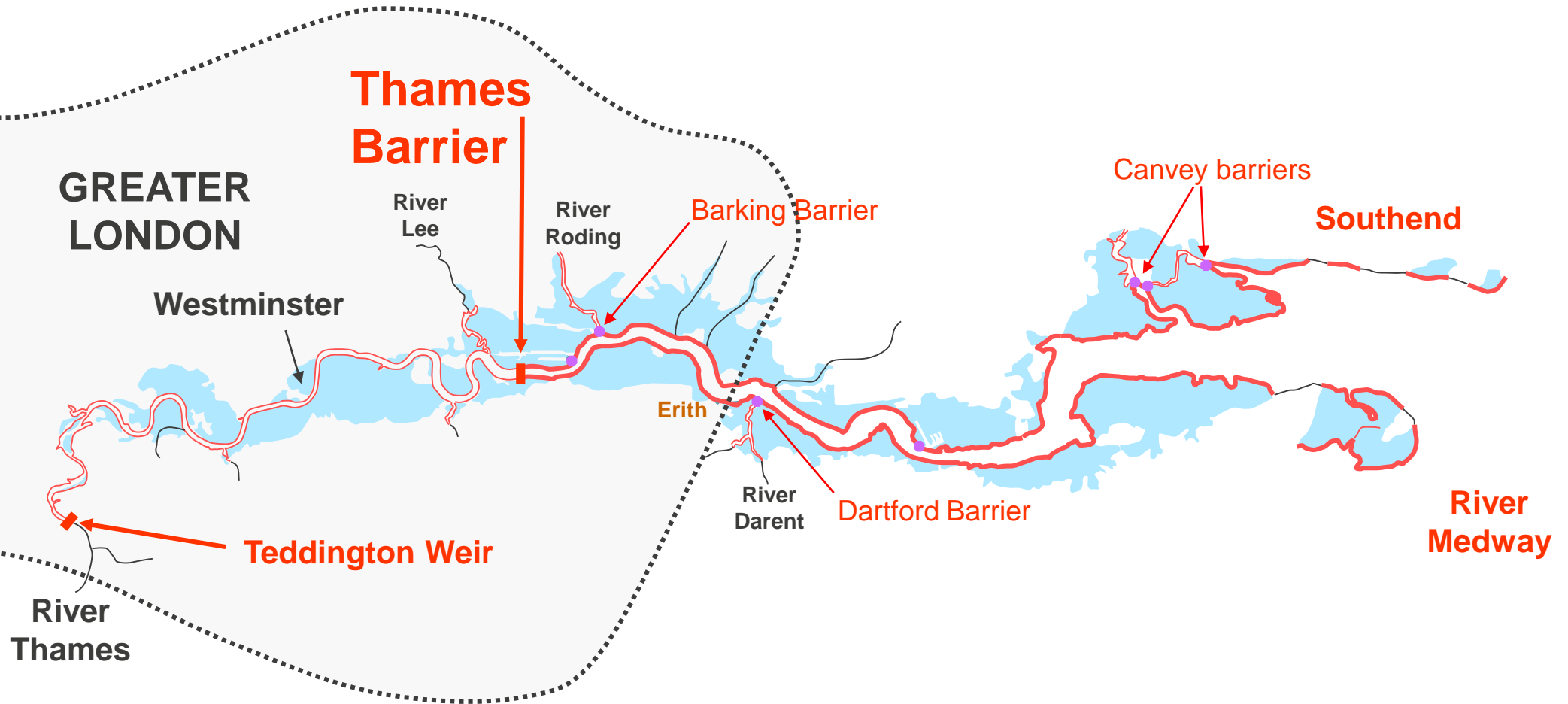


Decision making in uncertainty
**Adaptive Management of Infrastructure –
the TE2100 concept**

27th April 2017

David Ramsbottom

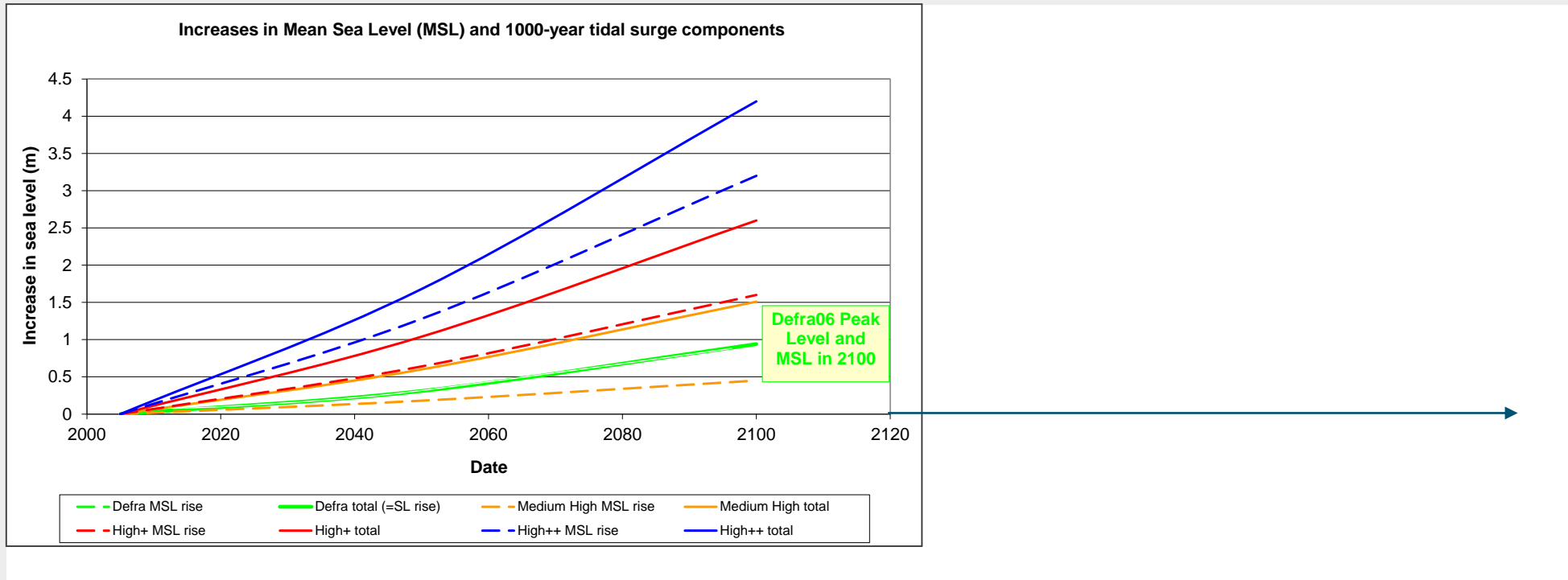
The Thames estuary



Length of estuary: About 100km
Length of defences: About 350km
Number of properties in floodplains: About 540,000

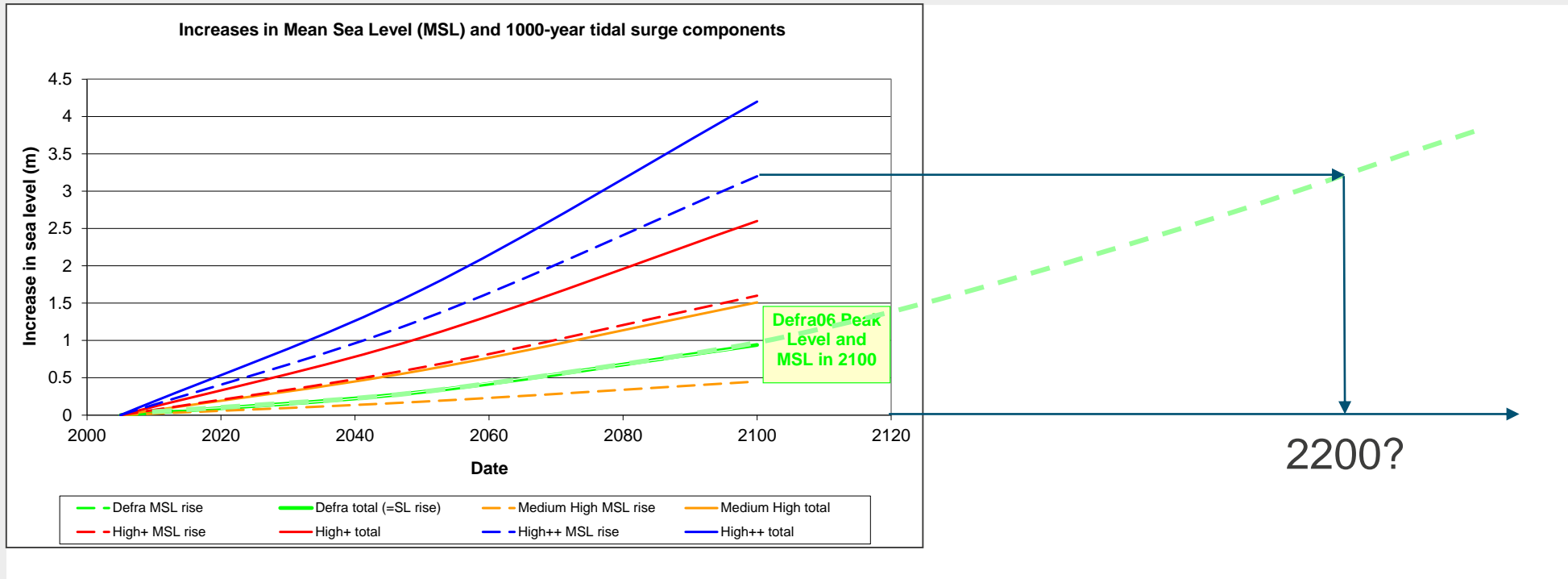
	Primary defences
	Secondary defences

Climate change scenarios: sea level rise



Range of Mean Sea Level rise by 2100: 0.5 m to 3.2 m

Climate change scenarios: sea level rise

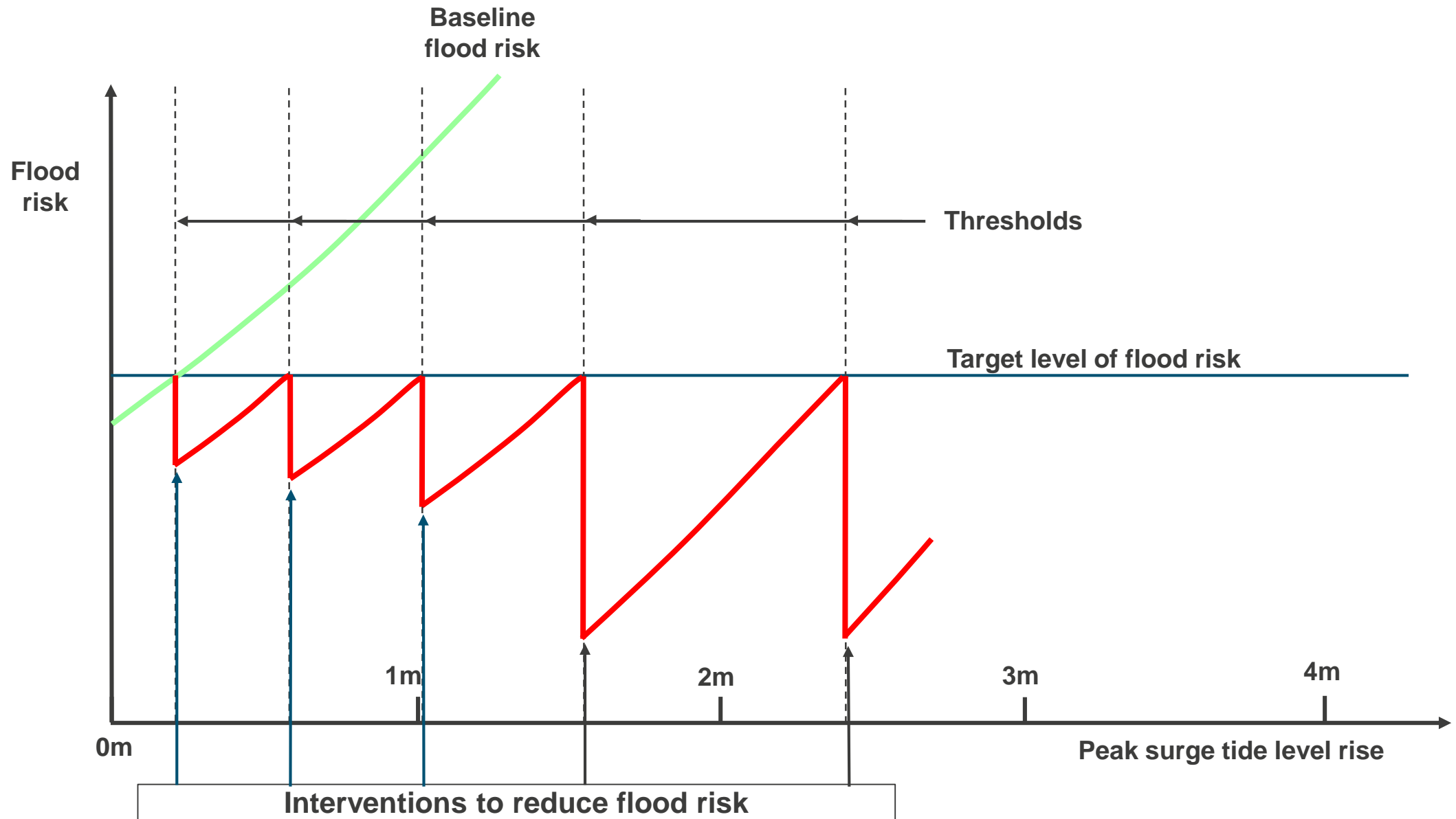


Even if the worst case scenario does not happen by 2100, it is likely to happen eventually

Infrastructure with a long design life must cope with these scenarios

1. What climate change impacts must we consider?
2. What scenarios of future change should we consider?

The concept: An adaptive option for flood management



Timing of intervention depends on rate of sea level rise

A physical limit, for example a level or a temperature

The frequency that the limit can be exceeded should be defined

A physical limit, for example a level or a temperature

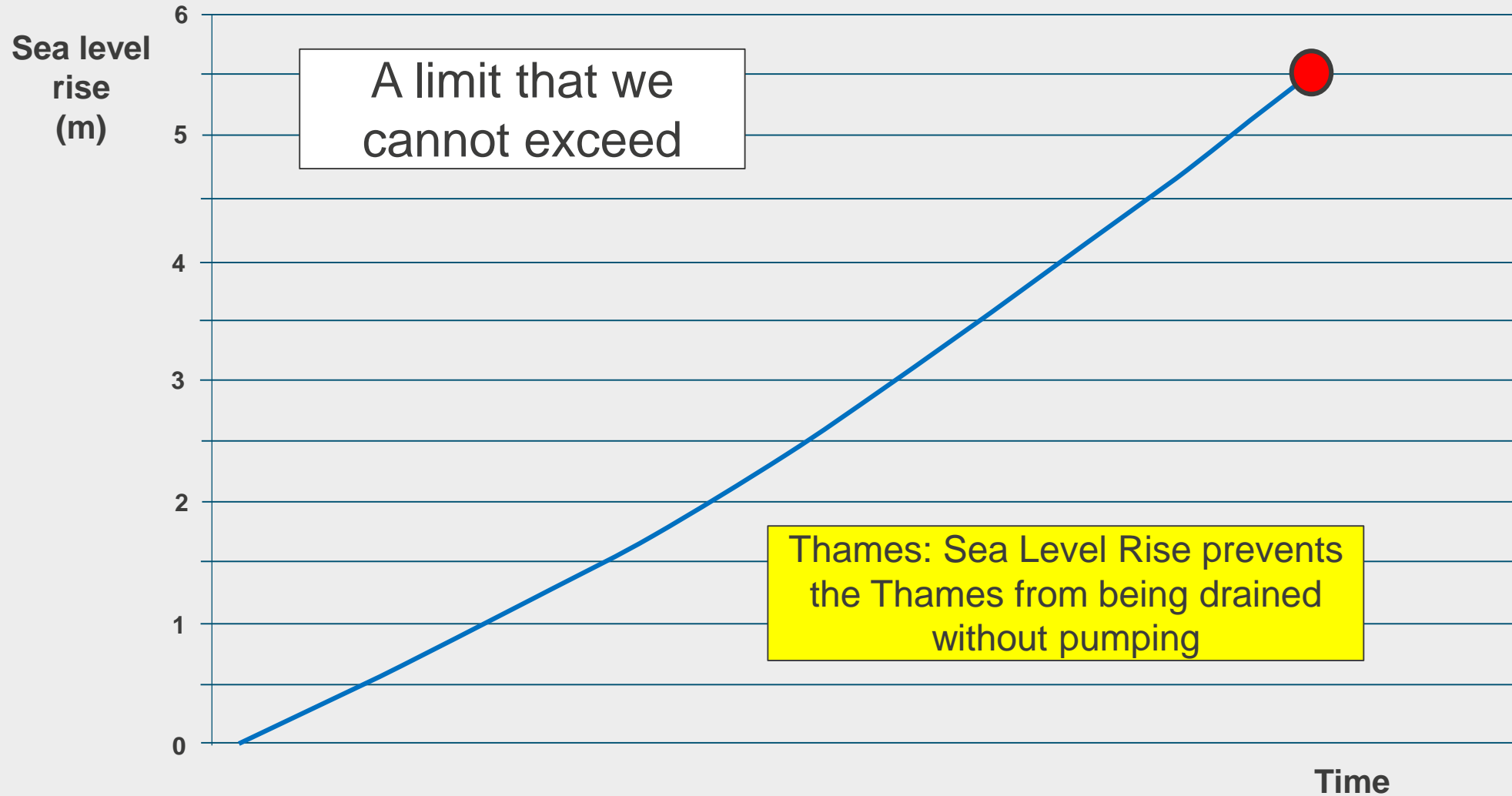
The frequency that the limit can be exceeded should be defined

Thresholds on the Thames estuary:

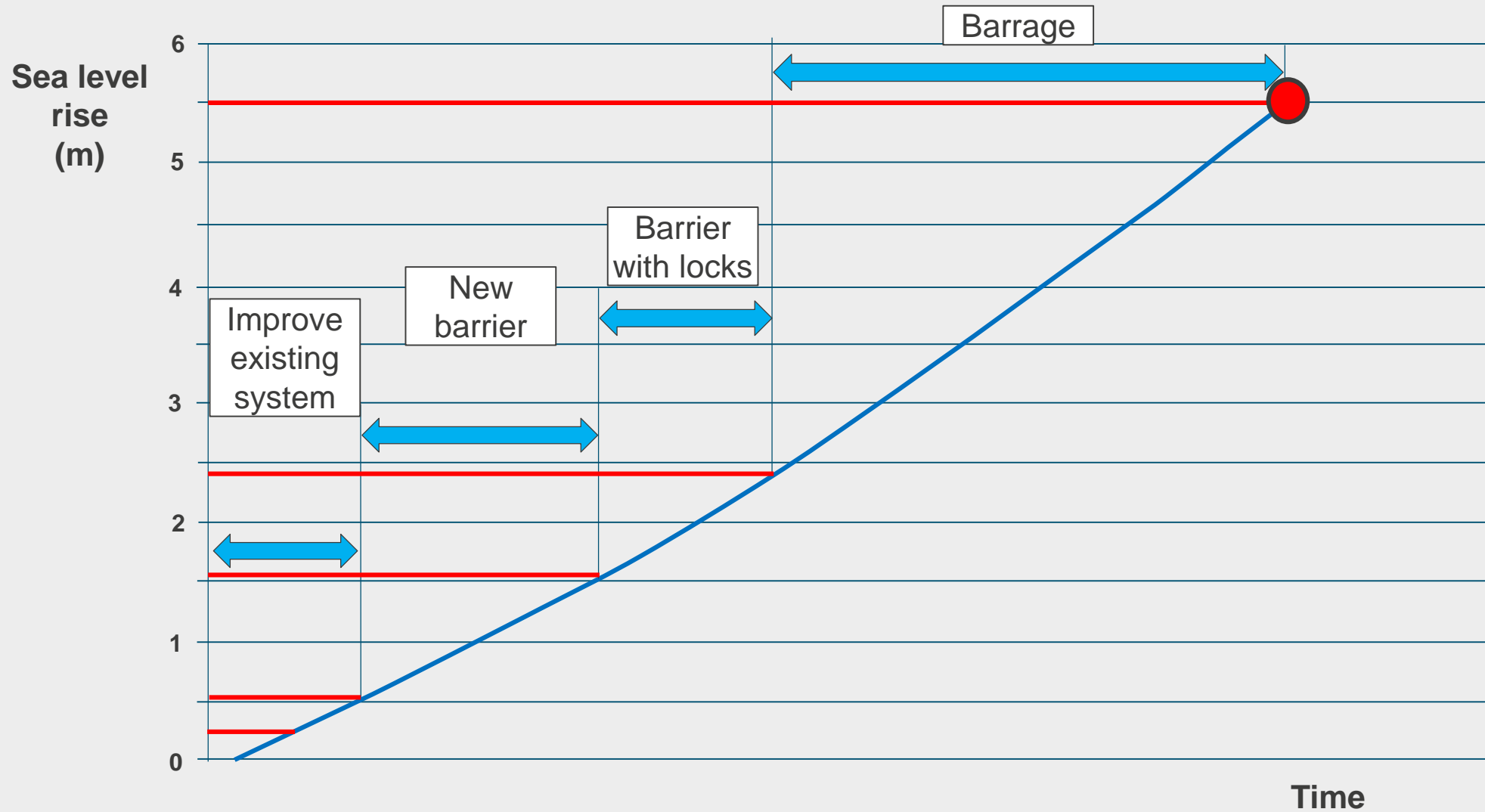
Flood defence level that is exceeded once in 1,000 years

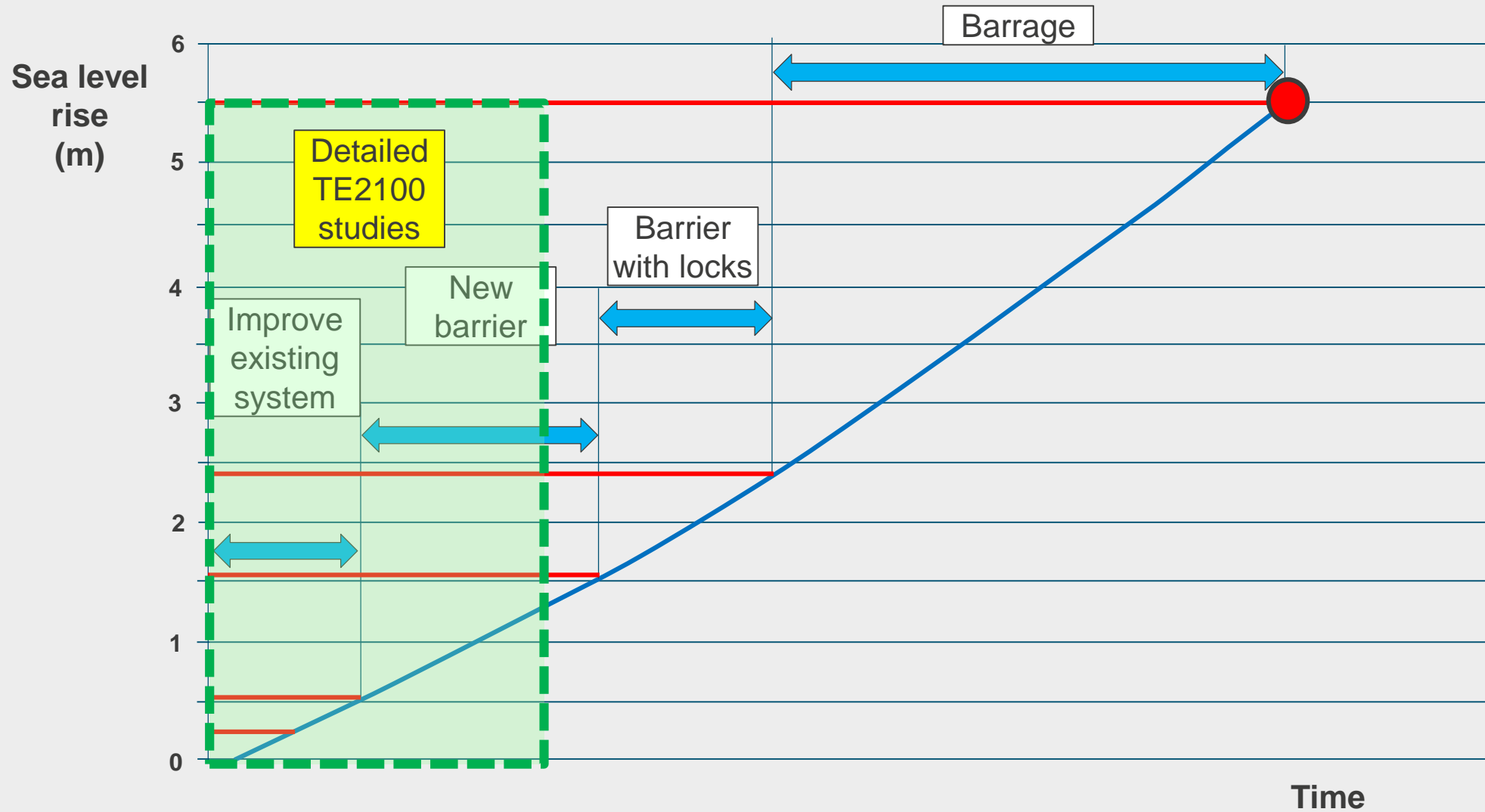
A maximum frequency of flood barrier closure

1. What climate change impacts must we consider?
2. What scenarios of future change should we consider?
3. How are the thresholds defined?
4. What are the thresholds for change?



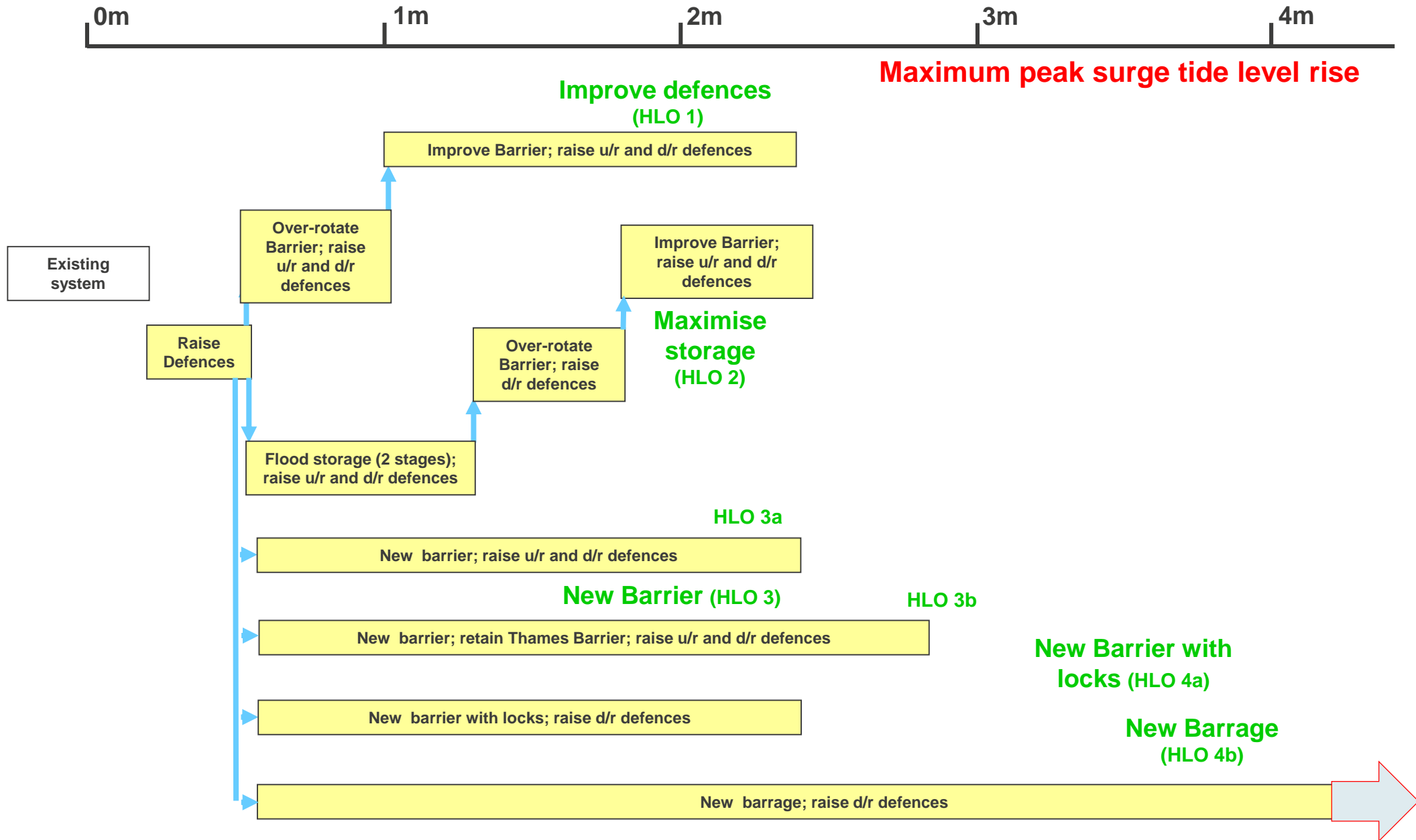
Adaptation pathway



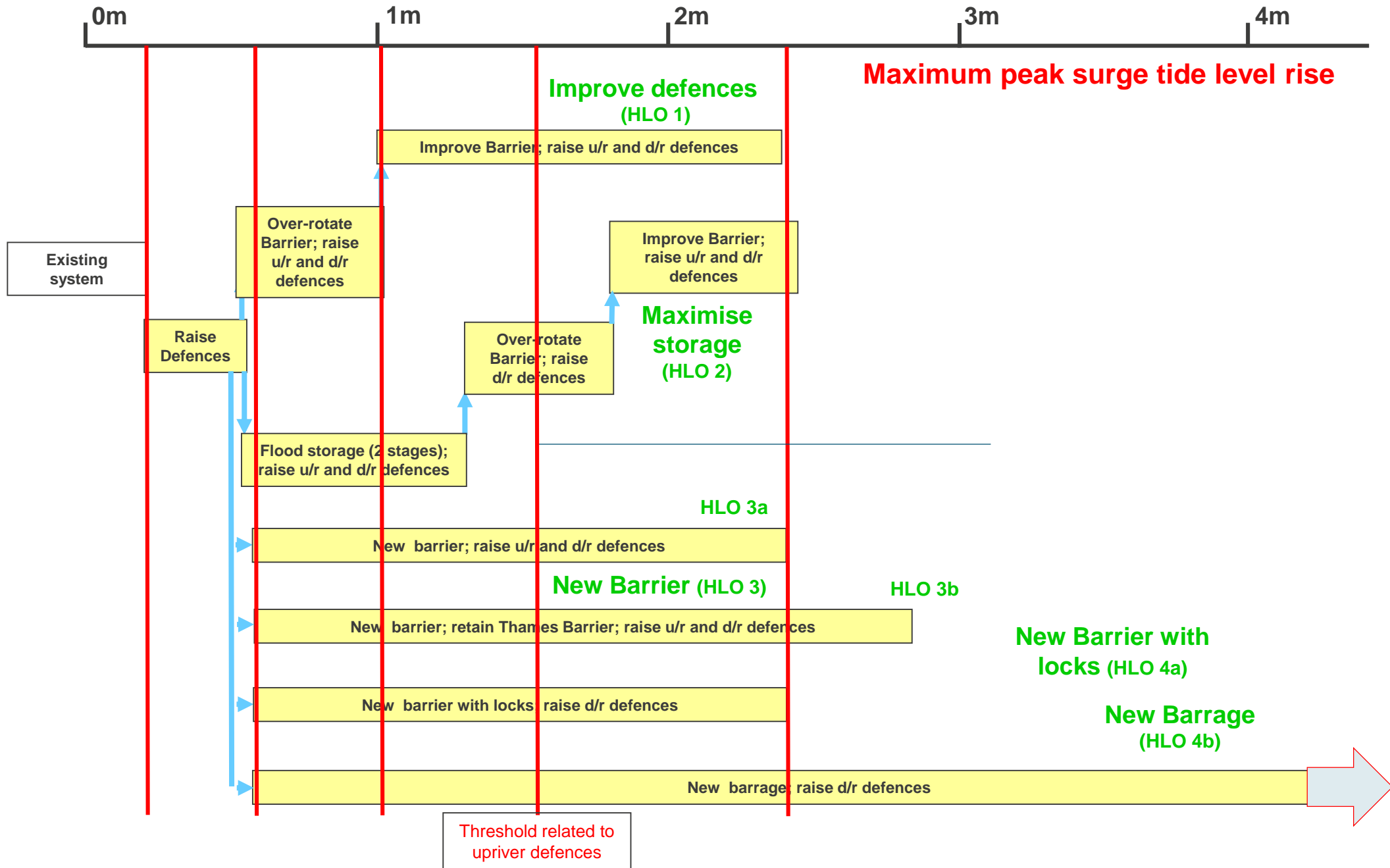


1. What climate change impacts must we consider?
2. What scenarios of future change should we consider?
3. How are the thresholds defined?
4. What are the thresholds for change?
5. What is the limit of adaptation?

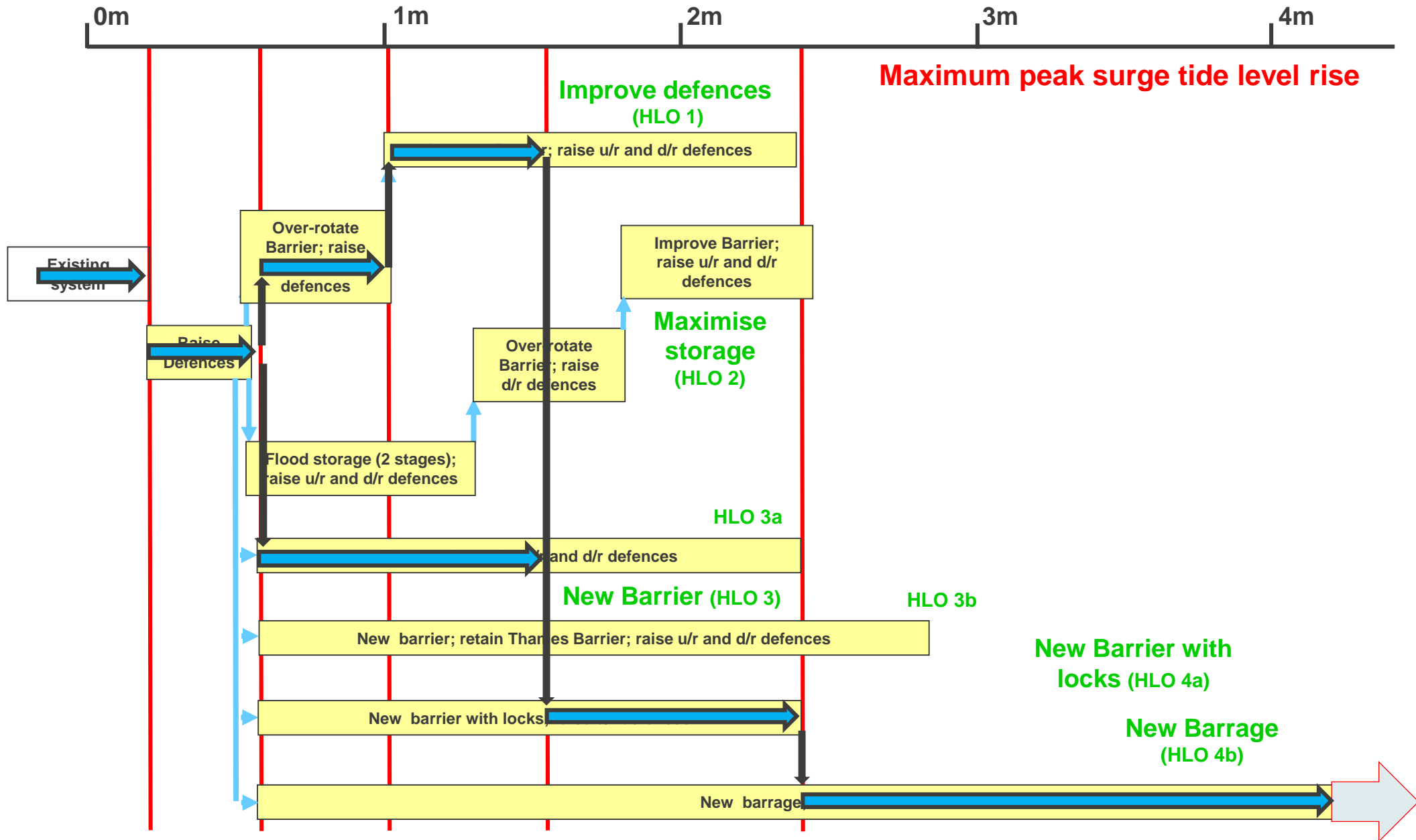
Adaptation options for sea level rise



Thresholds for sea level rise



The preferred option for sea level rise



1. What climate change impacts must we consider?
2. What scenarios of future change should we consider?
3. How are the thresholds defined?
4. What are the thresholds for change?
5. What is the limit of adaptation?
6. What options are available for different amounts of change?
7. What sequences of adaptation are possible?

Change in threshold definition (e.g. increase in standard)

Condition of assets and deterioration

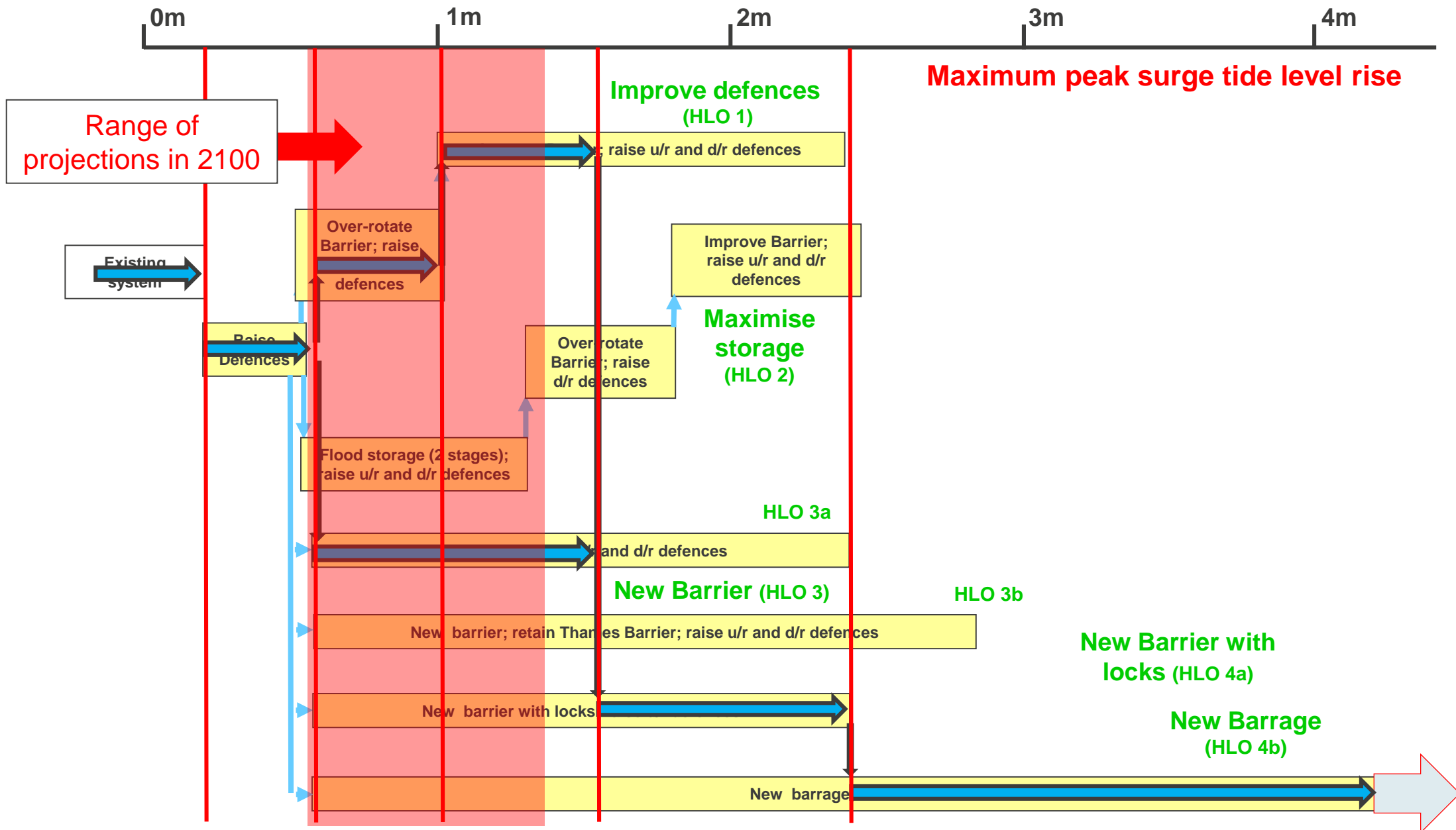
Other requirements (environmental, etc.)

New requirements

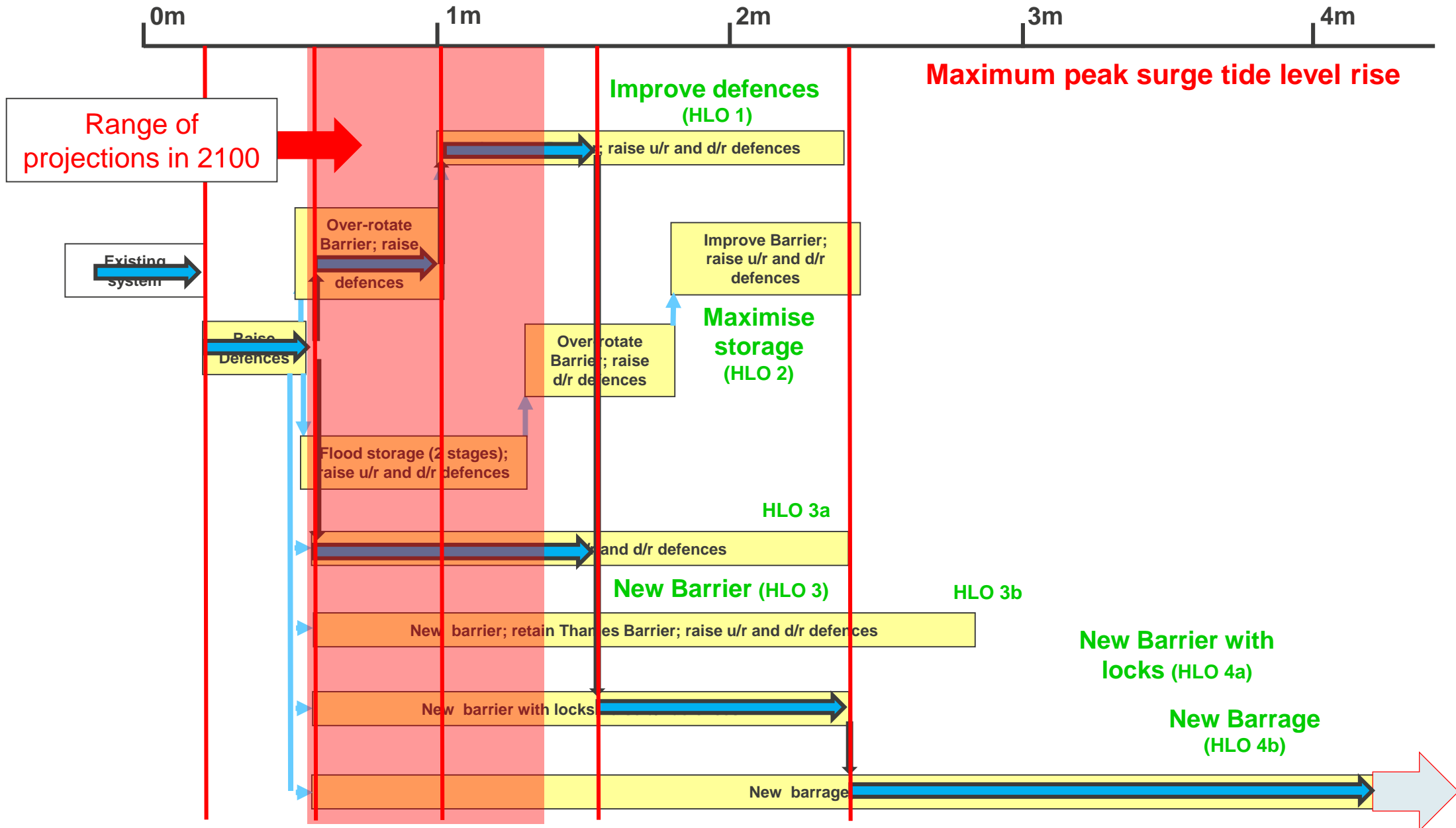
New technology

1. What climate change impacts must we consider?
2. What scenarios of future change should we consider?
3. How are the thresholds defined?
4. What are the thresholds for change?
5. What is the limit of adaptation?
6. What options are available for different amounts of change?
7. What sequences of adaptation are possible?
8. **Are there any constraints with existing infrastructure (e.g. residual life)?**

The preferred option for sea level rise



The preferred option for sea level rise



Need to monitor indicators of change and periodically update Plan

1. What climate change impacts must we consider?
2. What scenarios of future change must we consider?
3. How are the thresholds defined?
4. What are the thresholds for change?
5. What is the limit of adaptation?
6. What options are available for different amounts of change?
7. What sequences of adaptation are possible?
8. Are there any constraints with existing infrastructure (e.g. residual life)?
9. **What indicators should we monitor?**



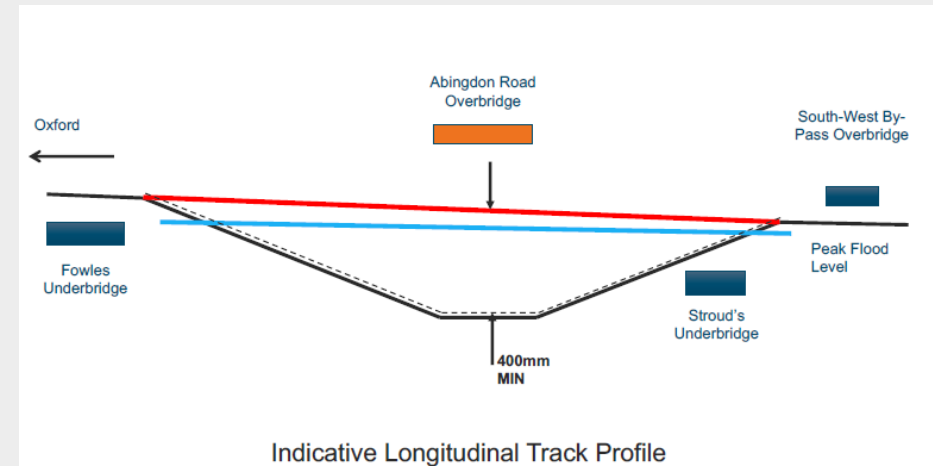
The solution (for now)

Flooding 11 times in the last 14 years

Section of track raised

New culvert to increase flow capacity under the track

Design standard the 1 in 20-year flood (others sections flood at this standard)



Illustrations: Paul Armitage, Network Rail

What climate change impacts must we consider?

River flow (in this case)

What scenarios of future change must we consider?

Current projections of increases in flow (25% to 70% by 2080s)

Take account of the Oxford FAS (20% increase in 100-year flow capacity)

What about the longer term?

How is the threshold defined?

Frequency of fluvial flooding

What are the thresholds for change?

A certain frequency of flooding: is 1 in 20 years a satisfactory standard?

What would an unsatisfactory standard be (when changes are needed)?

What is the limit of adaptation?

Physical limitation, when it becomes cheaper to re-route?

What measures are available for different amounts of change?

Resilience of infrastructure and trains: keep levels as they are

Raise the track (and associated infrastructure)

Flood protection, but difficult on a permeable floodplain

What sequences of adaptation are possible?

Need to identify measures and confirm feasibility, then develop adaptation pathway

Are there any constraints with existing infrastructure (e.g. residual life)?

This will affect the dates when measures are implemented

What indicators should we monitor?

Flood data including peak flood flows and water levels

Update estimates of present day and future flood flows and levels

Traffic on the railway (hence disruption losses)



Thank you