Flood risk management of estuaries under a changing climate - a UK perspective

RAETCS16

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Overview

The challenge

A risk-based approach:
- An example from the UK: the Humber Estuary

Long-term adaptation:
- An example from the UK: the Thames Estuary

Summary
The Challenge: planning in an uncertain future

**Climate change**
- temperature
- precipitation
- sea level rise
- river discharge
- wind

**Socio-economic change**
- population growth
- urbanisation
- market forces GDP
- legislation
- science, eng. & tech.
- public attitudes / preparedness

**Physical change**
- deterioration of defences
- morphology
- land subsidence
- conveyance capacity
- land-use change

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The traditional response to floods in the Thames
(picture courtesy: Rachel Hill, Environment Agency)
A risk-based approach

**Source**
Extreme distribution of in-channel water levels or coastal overtopping

**Pathway**
- Reliability analysis of assets e.g. defences (load dependent)
- Flood probability, flood extent and depth, reflecting asset performance and source terms.

**Receptor**
e.g. property, agriculture, infrastructure, people in the floodplain

**Consequences**
Flood damage or harm related to depth. Risk is assessed by the probability that particular damage values are exceeded.
6-7m tidal range
235 km of levees protect 60,000 residential and commercial properties and extensive agricultural land valued at £7 billion

Courtesy of Environment Agency
Humber tidal floodplain

Tidal fluvial interaction

Surge, tide, waves
Likelihood of tidal flooding for the present day - 2013
Likelihood of tidal flooding if we do nothing - 2112
Present value damage if we do nothing £4.8B
Present value damage if we do minimum maintenance £2.4B
Contribution to damage from individual levees - 2113

Breach

Overtopping

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The Thames Estuary

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

Tidal Range ~7m
Surge ~3m

Thames Barrier
GREATER LONDON
Westminster
Teddington Weir
River Thames

River Lee
River Roding
Barking Barrier
Erith
Dartford Barrier
Canvey barriers
Southend
River Medway

Primary defences
Secondary defences
Even if the worst case scenario does not happen by 2100, it will happen

Sustainable cities must cope with these scenarios
Maximum peak surge tide level rise:

- Improve defences (HLO 1)
  - Improve Barrier; raise u/r and d/r defences
  - Over-rotate Barrier; raise u/r and d/r defences

- Maximise storage (HLO 2)
  - Flood storage; raise defences

- New Barrier (HLO 3)
  - New barrier; raise u/r and d/r defences
  - New barrier; retain Thames Barrier; raise u/r and d/r defences

- New Barrier with locks / Barrage (HLO 4)
  - New barrier with locks; raise d/r defences

HLO: High Level Options: Each option has several sub-options (e.g. different barrier locations)
Maximum peak surge tide level rise:

- **Improve defences (HLO 1)**
  - Improve Barrier; raise u/r and d/r defences
  - Over-rotate Barrier; raise u/r and d/r defences

- **Maximise storage (HLO 2)**
  - Flood storage raise defences

- **New Barrier (HLO 3)**
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  - New barrier with locks; raise d/r defences

**Climate change scenarios used for planning:**

- Defra 2100
- Medium 2100
- High 2100
- High + 2100
Maximum peak surge tide level rise:

- **Range of projections in 2100**
- **Existing system**
- **Raise Defences**
- **Flood storage raise defences**
- **Maximise storage (HLO 2)**
  - Over-rotate Barrier; raise u/r and d/r defences
- **New Barrier (HLO 3)**
  - New barrier; raise u/r and d/r defences
  - New barrier; retain Thames Barrier; raise u/r and d/r defences
  - New barrier with locks; raise d/r defences
- **New Barrier with locks / Barrage (HLO 4)**
  - New barrage; raise d/r defences

Climate change scenario:

- Need to monitor indicators of change and periodically update Plan

Current Government (Defra) Climate Change Scenario
Increase in sea level

Different rates of sea level rise, which will affect the timing of interventions

Projected sea level rise

Threshold 6

Threshold 5

Threshold 4

Threshold 3

Threshold 2

Threshold 1

2016

Time

Barrage

Barrier with locks

Raise upriver defences (0.5 m)

Improve Thames barrier or new barrier

Raise upriver defences (0.5 m)

Raise some downriver defences
Summary

• Flood risk management decisions are becoming increasingly complex

• Risk-based approaches support decision making:
  • powerful tool to quantify & communicate flood risk to stakeholders
  • assist in the prioritisation of spending to maintain flood defences

• Longer term strategies must be adaptable to future change

• Timing of change plays an important role in planning for the future
Thank you

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