Coastal flooding: research examples from the UK
Matthew Wadey
Robert Nicholls, Ivan Haigh

National Oceanography Centre
University of Southampton
Waterfront Campus
European Way
Southampton SO14 3ZH
United Kingdom
Background: coastal flooding in the UK
UK coastal flood research & management

- Some regions very susceptible to SLR, fast adaptation methods needed
- Areas where flooding not well understood
- Existing approaches do not capture consequences of individual events
- 2010: Storm Xynthia (Atlantic France, 60 killed)
Ph.D. research
Aims & objectives

* Develop a flood simulation method
  * Defence failures & dynamics of flood events
  * Practical (fast run-time, easily understood outputs)

* Apply to a case study
  * Consequences of coastal flood events not well understood
  * Validation
  * Assess detail/resolution

Sources:
Offshore and nearshore waves and water levels

Pathways:
Shoreline response, breach, overtopping and floodplain flow

Receptors (people, property) and consequences (damage, disruption)
Historically prone to coastal flooding

500km shoreline, ad-hoc defences

25,000 properties exposed to 1 in 200 year coastal flood

Half this exposure in Portsmouth

21st century: significant coastal flood risk increases expected (Evans et al., 2004; Haigh et al., 2011)

The Solent: a south coast case study
Methodology

1. Define loading ranges
2. Compile defence data
3. Floodplain topography

**Exposure**
Define maximum floodplain

**Hydraulic modelling**
Combine: loads, defence failures, 2D numerical flood simulation

**Validation case studies**
Simulate real events

**Simulate synthetic flood events**

**Regional analysis**
**Detailed analysis**

---

Model inflow points & peak SWL for 19 March 2008 flood simulation:
- 1.8 - 2.3
- 2.4 - 2.6
- 2.7 - 2.8
- 2.9 - 3.0
- 3.1 - 3.3

Model domain (DEM elevation in mAOD):
- High: 241.1
- Low: -3.6

Legend:
- Red: Total zones (EA, 2007)
Validation

- Events simulated using historic boundary conditions, defence data etc.
- 10 March 2008: regional 1 in 10 - 1 in 50 event - mainly small floods & near misses
- Photos (>300), media reports etc. observed vs. modelled
- Good spatial match; verified defence failures, DEM etc.
- Depth threshold for entry to properties ~0.5 m
Regional-Scale Coastal Flood Modelling
Properties most likely to experience damage using 1 m depth criteria
- Greater rate of increase with SLR
Increased detail – city of Portsmouth

- Friction & resolution
  - Flood extent sensitive to inclusion of surface features
  - Coarser DEM: larger flood extent
  - Finer DEM: more damages
  - Less interpolation: allows identification of important thresholds for SL & waves to exert damages

- Modeller decisions crucial to predicted outcome
  - Schematisation of secondary defences
  - Likely management responses (i.e. blocking tunnels, breaches)
Applications – flood visualisations

- CCATCH - project to educate coastal communities about impacts of climate change
- Schools, local residents
- Model simulations applied to visualisations

3D output – ‘flythrough’ visualisation
Discussion – flood event analysis

- Simulations suggest 1 in 200 year SL could cause significant damage e.g. 10,237 properties = £1 Bn damages (reduced to £23 Mn at >1m)
- Mid-prob SLR (UKCP09 2050: 18-26 cm south UK):
  - 10 March 2008 becomes 1 in 1 year event
  - or: event with the same probability (~1 in 10) exerts >fourfold increase in impact's *(assuming existing defences maintained, but not upgraded)*

**Flood event monitoring is important**

- Needs to be undertaken more systematically
- Historical perspective on events & planning decisions
- Helps to understand modelling uncertainties & data gaps
- Engages public
Future work / applications

- Increase model extent, resolution & analysis of past events
- Improve understanding of flood mechanisms
- Assess health & economic impacts
Validated coastal flood simulation method: improves understanding of coastal flooding
* Defence failures, inundation events, ‘forensic’ flood event assessment
* View consequences across range of loadings & defence responses
* Shows flooding as a present-day threat & will grow with SLR

Different adaptation required for the region’s two cities
* Southampton - no existing defences
* Portsmouth - long defended coastline, landfills, greater hazard

Applications
* Scenario assessment tool - inform adaptation options
* Flood forecasting & warning, coastal management
* Flexible tool, platform for further research...
Current work – storm & flood clustering

* Seriality of storms: cumulative insurance losses comparable to a catastrophic hurricane
  * 8 storms Dec 1989 - Jan 1990, €10.5 bn
  * 2 storms Christmas 1999, €18.5 bn

* ‘Flood MEMORY’ Project
  Analyse situations where 2\textsuperscript{nd} flood strikes before defences reinstated / householders & businesses vulnerable (‘memory period’)

Source: Mailier et al, 2006
http://www.janews.com/
http://www.kentonline.co.uk/
Coastal flooding & extreme sea levels

Usually characterised by return period

- Sea level = tide + surge + MSL
- Applications: e.g. inundation modelling, risk management

But...individual events are complex spatially & temporally

* Prolonged storms, high tides & smaller successive events important
* Spatial ‘footprint’ of surges & extreme sea levels
* Surge event database & website


**Acknowledgements**

* Data provided by: Channel Coastal Observatory (www.channelcoast.org); British Oceanographic Data Centre (BODC)

* Flood “MEMORY” consortium (Multidisciplinary EPSRC-funded flood research project)

  *Multi-Event Modelling Of Risk & recoverY research partners:*
    - The University of Newcastle (Coordinator)
    - The University of Nottingham
    - Queen Mary, University of London
    - Swansea University
    - Herriot-Watt University
    - University of the West of England
    - Cranfield University
    - National Oceanography Centre / University of Liverpool
    - National Oceanography Centre / University of Southampton.
Thanks for listening!
Questions?

m.p.wadey@soton.ac.uk