Sea level rise impacts and adaptation in Europe

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Matthew Wadey, Ivan Haigh, Jochen Hinkel, Sally Brown, Nassos Vafeidis, and RISES-AM Consortium
Conference outcome

The conference will serve as a basis for a new assessment of the state-of-the-art on regional sea level research that will be an important input to the next IPCC assessment.

A major outcome from the conference will therefore be an evaluation of the current state of sea level science, an outline of future research requirements for improving our understanding of sea level rise and variability and a description of the observational requirements (both experimental and sustained systematic observations).

The outcomes will be published in multiple forms, including an agenda setting peer-reviewed paper specifying the information on coastal seal level change required by coastal communities for adaptation and decision making purposes.

In detail the conference will:

I. Identify the key factors contributing to past, present and future regional sea level rise and variability.

II. Organize a systematic attack on the error budget of these factors.

III. Identify stakeholder needs for sea-level information for coastal planning and management purposes.

IV. Define the requirements for new and augmented research, technical development and observations consistent with the above.

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For full conference program see www.sealevel2017.org
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Benefits of adaptation (globally)

- Without additional adaptation: The expected number of people flooded continues to grow.
- With additional adaptation: The number of people flooded decreases, despite, in some scenarios, a growing population.

Hinkel et al. (2014): doi:10.1038/nclimate2505
Port City Locations

>1 million population in 2005
136 locations

Key global results for the flood plain
- 40 million people
- 0.6% of global population
- (10% of port city population)
- US $3000 billion of assets
- 5% of global GDP

Nicholls et al., 2008
Port City Exposure by Continent in 2005

(a) Population

(b) Assets

Exposed assets (US$mn)

Exposed population (000s)

Nicholls et al., 2008
Exposed Assets 2005
Top 20 Coastal Cities Worldwide

Nicholls et al., 2008
Expected annual losses 2005
Top 20 Coastal Cities – Absolute Losses

Top 20 cities ranking by risk, with protection in 2005.
Average annual losses. Millions US dollars.

Hallegatte et al., 2013
Hallegatte et al (2013)
Conclusions for Global Coastal Cities by 2050

• With climate change and subsidence, present protection will need to be upgraded to avoid unacceptable losses (of US$1 trillion or more per year).

• Even if adaptation investments maintain constant flood probability, subsidence and sea-level rise will increase global flood losses substantially (to US$60–63 billion per year). To maintain present flood risk, adaptation will need to reduce flood probabilities below present values.

• In this case, the magnitude of losses when floods do occur would increase, often by more than 50%, making it critical to also prepare for larger disasters than we experience today. This is an expression of residual risk.
Recent Extreme Events in Europe
Jan/Feb 1953 vs. Dec 2013 Surges

Wadey et al., 2016
1953 vs. 2013
Surge Events

Wadey et al., 2016

WL – Water Level; SS – Storm Surge
1953 vs. 2013 Surge Events

(a) Water Level

(b) Return Period

(c) Return Period

(d) Skew Surge

Wadey et al., 2016
## 1953 vs. 2013 Surge Impacts (UK only)

<table>
<thead>
<tr>
<th>IMPACT CATEGORY</th>
<th>1953</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEATHS (FLOOD RELATED)</td>
<td>307</td>
<td>0</td>
</tr>
<tr>
<td>PEOPLE EVACUATED</td>
<td>32,000</td>
<td>18,000</td>
</tr>
<tr>
<td>PROPERTIES FLOODED</td>
<td>24,000</td>
<td>2,800</td>
</tr>
<tr>
<td>DEFENCE BREACHES</td>
<td>1200</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>LAND INUNDATED (KM²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRICULTURE</td>
<td>650</td>
<td>68</td>
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<tr>
<td>TOTAL</td>
<td>834</td>
<td>N/A</td>
</tr>
<tr>
<td>INDUSTRIAL SITES INUNDATED</td>
<td>200</td>
<td>N/A</td>
</tr>
<tr>
<td>LIVESTOCK</td>
<td>47,000 cattle</td>
<td>&lt;100 cattle</td>
</tr>
<tr>
<td></td>
<td>140,000 poultry</td>
<td>700,000 poultry</td>
</tr>
<tr>
<td>ENERGY SUPPLY</td>
<td>2 power stations, 12 gas works</td>
<td>1 electricity sub-station</td>
</tr>
<tr>
<td>PORTS IMPACTED</td>
<td>Tilbury, Felixstowe</td>
<td>Immingham</td>
</tr>
<tr>
<td>TRANSPORT IMPACTS (KM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROADS</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>RAILWAYS</td>
<td>320</td>
<td>200</td>
</tr>
<tr>
<td>COST (£ BILLIONS)</td>
<td>1.2</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Wadey et al., 2016
Cyclone Xynthia, France, 2010

Atlantic Storm ‘Xynthia’: 1.5m surge and large waves
~60 dead, lack of emergency planning & warning

Kolen et al., 2010
Case Study: The Solent, UK

- Historically prone to flooding (Ruocco et al, 2011)
- 25,000 properties exposed to a 1 in 200 year coastal flood event
- Approx. half exposure in Portsmouth

Wadey et al., 2012
Solent Floods: 10 March 2008

Photos from EA, (2010)
Solent Floods: 10 March 2008

Yarmouth

Floating Bridge, West Cowes
Extreme Sea Levels and Floods in the Solent

Ruocco et al., 2011
Modelled Flood Events in the Solent
Loads & failure mechanisms vs. number of properties flooded to positive depth (> 0 metres)

Wadey et al., 2012
Conclusions

- Europe has relatively high exposure globally, especially in north-west Europe.
- Risk (expected annual damages, risk to life, etc.) is globally low and we seem to be coping with current challenges.
- However, residual risk remains a challenge and “surprises” such as Xynthia are inevitable without a strongly proactive approach to adaptation.
- This will be true even with strong mitigation – but the rates of change will be slower and give more time to prepare.
- The challenge is to consider:
  1. How to move from reactive to proactive management making full use of our simulation capabilities to explore future states;
  2. Residual risk in meaningful ways;
  3. The range of potential change beyond 2100 – the notion of coastal adaptation being a multi-step process.
Key Sources

- SurgeWatch -- A Database Of UK Coastal Flood Events https://www.surgewatch.org/
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