Panel VII: Port Sustainability in a Changing Climate

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Outline

• Sustainability
• Climate Change Scenarios
• Adaptation
• Mitigation
• Conclusions
‘Sustainability’ is a rich concept, but difficult to capture in a single succinct definition

The Brundtland Report (The 1987 UN World Commission on Environment and Development Report) definition is well known:

“Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs”

- **Adaptation** – planning to adapt to the committed changes in climate
- **Mitigation** – actions to reduce future climate change
Climate Change Scenarios

- High levels of uncertainty in most predictions
- Variations largely based upon emissions scenarios
- General agreement in direction of change for most key variables, e.g. sea level rise

• Global average (eustatic) sea level rise projections from IPCC 4th Assessment Report range from 18cm to 59cm, or 1.5 to 9.7mm/year, by 2099
• Does not include subsidence

Changes at the coast and estuaries

- Mean sea-level rise accelerating
- Tidal patterns could be influenced
- Increased storminess
  - Storm Surges may increase in height
- Increase in wind speeds
- Wave heights may change
Estuary landform impacts

- Insufficient sediment to accrete vertically to match sea level rise
- Increased tidal prism, increasing tidal energy - erosion
- Landward structures prevent the ‘natural’ migration, resulting in narrowing intertidal areas
- This could result in increased energies at structures, and operational implications
Potential Impacts on Port Structures

• Assessment of potential impacts of increased sea levels on port operations
• Considered two typical port structures
  – Quaywall (vertical wharf)
  – Breakwater
• Water level increases of:
  – 125mm, 200mm, 250mm, 500mm
• Assumed wave height (2m) and period (8.5sec) for storm condition
• Deep water structures (-15m)
• Calculated increase in overtopping
## Breakwater Overtopping

<table>
<thead>
<tr>
<th>Water Level (m)</th>
<th>Offshore Wave Height (m)</th>
<th>Wave Period (s)</th>
<th>Crest Height (m)</th>
<th>Overtopping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volume</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(l/s/m)</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>8.5</td>
<td>1.81</td>
<td>200</td>
</tr>
<tr>
<td>0.125</td>
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<td>2</td>
<td>8.5</td>
<td>1.81</td>
<td>262</td>
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<tr>
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<td>2</td>
<td>8.5</td>
<td>1.81</td>
<td>344</td>
</tr>
</tbody>
</table>
Implications

- Increased wave agitation in port basin
  - exceed movement criteria for berthed vessels = downtime
- Also, increased storminess would cause this to occur more frequently
- Increased downtime can have severe impacts where operating to fixed schedules
  - Potential loss of trade to ‘better protected’ ports
Quawall structures
### Quaywall Overtopping

<table>
<thead>
<tr>
<th>Water Level (m)</th>
<th>Offshore Wave Height (m)</th>
<th>Wave Period (s)</th>
<th>Crest Height (m)</th>
<th>Overtopping Volume (l/s/m)</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>8.5</td>
<td>4.53</td>
<td>0.40</td>
<td>-</td>
</tr>
<tr>
<td>0.125</td>
<td>2</td>
<td>8.5</td>
<td>4.53</td>
<td>0.47</td>
<td>16%</td>
</tr>
<tr>
<td>0.2</td>
<td>2</td>
<td>8.5</td>
<td>4.53</td>
<td>0.54</td>
<td>35%</td>
</tr>
<tr>
<td>0.25</td>
<td>2</td>
<td>8.5</td>
<td>4.53</td>
<td>0.58</td>
<td>45%</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>8.5</td>
<td>4.53</td>
<td>0.85</td>
<td>112%</td>
</tr>
</tbody>
</table>
Implications

- Higher water levels may affect vessel elevation relative to wharf
- Significant overtopping could cause flooding
- Likely to exceed yard drainage system – designed for lower volumes
- Extremely disruptive to operations
  - E.g. impacts at container terminals where area behind wharf used for container storage
  - Costs of damage to goods, plus future insurance costs
- Regular flooding could affect viability of port operation
Remedial Actions?

Breakwaters
- Increase crest height/size
- Install wave wall on crest

Quaywall
- Raise cope level - extremely disruptive
- Install wave wall along crest – very restrictive on quayside/landside operations
- Install set-back flood wall – possibly demountable structures?
- Modify drainage system to increase capacity
- Modify operations to remove facilities from flood prone areas
- Possible need to change height of fenders and mooring rings to maintain optimal performance
Cost Implications

• Cost implications will be very site specific
• Worst case:
  – Need to raise cope level of existing structures
  – Very costly construction, plus major impact on operations
  – Global shortage of (container) wharf capacity – can’t afford loss of berth while remedial works undertaken
• Demurrage not payable for ‘environmental’ delays
  – but frequent delays may cause shipping lines to consider alternative ports
• Increased flood damages, would result in increased insurance premiums
  – Passing on costs to shippers could make port less competitive

*Climate change considerations must be incorporated into future port planning and design: adaptable, resilient*
Mitigation

1. Sunlight passes through the atmosphere and warms the surface of the Earth

2. Infrared radiation is given off by the Earth...

3. ...most escapes to outer Space and cools the Earth...

4. ...but some IR is trapped by gases in the air, thus reducing the cooling

Stern Review
Port traffic and global warming

- Growing recognition of impact of shipping on CO2 emissions
- Shipping responsible for transporting 90% of world trade (doubled in 25 years) continued growth forecast
- Media spotlight turning on impacts of shipping emissions
  - UK Guardian, March 2007 “CO2 output from shipping twice as much as airlines… Aviation is in the firing line now but shipping needs to take responsibility”
Impact of Shipping

- Figures from BP, and research by the Institute for Physics and Atmosphere in Wessling:
  - shipping responsible for up to 5% of the global GHG total
- Lloyd’s Register Quality Assurance (London):
  - shipping traffic generates 7% of the total worldwide output of sulphur dioxide (SOx) - a key contributor to climate-change
- **Without action** the IMO predicts that by 2020, emissions from ships will increase up to 72%.
Currently undertaking study of forecast emissions resulting from predicted **300% growth in shipping** in BC to 2020

BC Chamber of Shipping Study indicates that in the Lower Fraser Valley Area, more than **50% of GHG emissions** from shipping **occur at berth**

Focus is on potential benefits of “**cold-ironing**” - connecting to **lower emission** shoreside energy supply while in dock

**Key Issues:**

1. Supply capacity
2. Port supply side infrastructure
3. On-board electrical connection (no standard)
4. Calling frequency
5. Vessel replacement rate
6. Costs
Alternative approaches

- Port of Oakland:
  - supply side capacity, infrastructure and cost issues. Mobile LNG generator demonstration project

- Port of Gothenburg (Sweden):
  - tax exemption for use of shoreside power = parity with costs of bunker fuel

- Port of Los Angeles and Port of Long Beach:
  - Co-operative effort between authorities, shipping companies and ports to promote and install shoreside power at numerous berths

- Port of Vancouver:
  - Harbour dues program – reduction for using low sulphur fuel

Facilitate & Incentivize
• Masterplan for consolidation of port activity and redevelopment of redundant land
• Includes “recycling industries cluster”
• Potential for inclusion of energy from waste and renewables – including wind energy to serve port
• Energy efficient design solutions for buildings promoted
• Halcrow prepared a development framework for port area
  – North Sea offshore oil and gas sector has peaked
• Synergies between oil and gas supply chain and offshore wind power acknowledged
• Wind turbine developed by port occupier
• Annual output = 2.75MW, saving 6215 tonnes of greenhouse gas emissions per year
Three Pillars of Sustainability:

**Environmental**
- Reducing GHG emissions from shipping
- Promotion of renewable energies at ports

**Social**
- Reducing harmful emissions
- Continued importance to local/regional communities

**Economic**
- Costs associated with climate change impacts
- Continued importance/growth in world trade
- Potential for green/alternative industries
Thank you

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Implications, contd.

- Conditions exceeding maximum operational wave heights for berthed vessels?
  - Depends on local factors such as fender type, vessel type, etc
- PIANC article estimates wave height values for different directions before loading/unloading operations are suspended.

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Limiting wave height Hs in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0° (head on or stern on)</td>
</tr>
<tr>
<td>General cargo</td>
<td>1.0</td>
</tr>
<tr>
<td>Container, ro/ro ship</td>
<td>0.5</td>
</tr>
<tr>
<td>Dry bulk, 30-100,000 dwt</td>
<td>1.5 (loading)</td>
</tr>
<tr>
<td>Tankers 30,000 dwt</td>
<td>1.5</td>
</tr>
<tr>
<td>Tankers 30,000 – 200,000 dwt</td>
<td>1.5 – 2.5</td>
</tr>
<tr>
<td>Tankers 200,000+ dwt</td>
<td>2.5 – 3.0</td>
</tr>
</tbody>
</table>

Source: PIANC Bulletin No. 56