Preparing for the Impacts of Climate Change on Facilities and Channels

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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
AAPA Sustainability Support

• AAPA Sustainability Task Force
• Sustainability Resolution approved October 2007:
  - Embraces sustainability concept as standard business practice
  - Sustainability involves simultaneous pursuit of economic prosperity, environmental quality and social responsibility
  - Port’s unique role in transportation, logistics
  - Ports must be financially viable to contribute to economic prosperity
  - Port activities may impact environment & natural resources
  - Ports recognize long term balanced approach required
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 (7 to 23 inches), 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

- Sediment supplies may not be sufficient to match sea level rise
- Increased tidal prism, increasing tidal energy
- Landward structures prevent the ‘natural’ migration, resulting in narrowing intertidal areas
- This could result in increased energies at structures, and operational implications
• Changing climate will change trade aspects such as agricultural production, goods consumption demand (crops, fuels import/export)
• Trade patterns and flows may alter over time
• Ports will need to adjust to changes in market
• Local windfarm trade an illustration of market change due to climate change/renewable energy growth
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:
  - 5 inches, 8 inches, 1 foot, 2 feet
- Assumed wave height (6.6 feet) and period (8.5 sec) for storm condition
- Calculated increase in overtopping
### Breakwater Overtopping

<table>
<thead>
<tr>
<th>Water Level (ft)</th>
<th>Offshore Wave Height (ft)</th>
<th>Wave Period (s)</th>
<th>Crest Height (ft)</th>
<th>Overtopping</th>
<th>Volume (g/s/ft)</th>
<th>Percentage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.5</td>
<td>8.5</td>
<td>5.9</td>
<td>175</td>
<td></td>
<td>-</td>
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<tr>
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<td>11%</td>
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<tr>
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<td>24%</td>
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<tr>
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<td>227</td>
<td>298</td>
<td>31%</td>
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<tr>
<td>24 in</td>
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<td>8.5</td>
<td>5.9</td>
<td>298</td>
<td></td>
<td>72%</td>
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</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
Quaywall structures
### Quaywall overtopping

<table>
<thead>
<tr>
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<th>Crest Height (ft)</th>
<th>Overtopping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volume (g/s/ft)</td>
</tr>
<tr>
<td>0</td>
<td>6.5</td>
<td>8.5</td>
<td>5.9</td>
<td>0.35</td>
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<tr>
<td>5 in</td>
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<td>8.5</td>
<td>5.9</td>
<td>0.41</td>
</tr>
<tr>
<td>8 in</td>
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<td>8.5</td>
<td>5.9</td>
<td>0.47</td>
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<td>12 in</td>
<td>6.5</td>
<td>8.5</td>
<td>5.9</td>
<td>0.51</td>
</tr>
<tr>
<td>24 in</td>
<td>6.5</td>
<td>8.5</td>
<td>5.9</td>
<td>0.74</td>
</tr>
</tbody>
</table>
Implications for Port Facilities

- 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
Implications for Channels

- Higher water levels may alter tidal prism / currents for ship access
- Possible increased damage to coastal channel control structures
- Possible changes in sediment movement at coast leading to entrance siltation impacts (ACOE funding)
- Changes in channel hydrodynamics may alter siltation patterns and therefore dredging
- Deeper water allows greater passing ship effects at berth
• Future dredge disposal implications?
  Dredge disposal – beneficial use (Pintail Flats for Golden Pass LNG TX shown)
• Existing disposal areas affected
Port Arthur Ship Canal, TX

- Effect on entrance channel/breakwaters?
- Change implication for channel access – currents/water levels
- Potential passing ship effects
• Higher water levels will have implication for bridge clearances
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 must be incorporated into future port planning and design*
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
  - 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%.
Way forward?

- 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
UK: Port of Sunderland

- 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
UK: Port of Lowestoft

- 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
Adaptation:
• Climate will change
• Physical conditions at ports and channels are likely to change
• Physical modifications to existing ports and channels may be difficult
• Need to ensure future conditions considered in all new designs

Mitigation:
• Shipping has significant climate impact
• Ports can play an important role in reducing emissions
• Also, ports can encourage/attract ‘green’ industries
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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