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Preparing for the Impacts of Climate Change on Facilities and Channels

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Outline

- Sustainability
- Climate Change Scenarios
- Adaptation
- Mitigation
- Conclusions

Sustainability

- **'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"

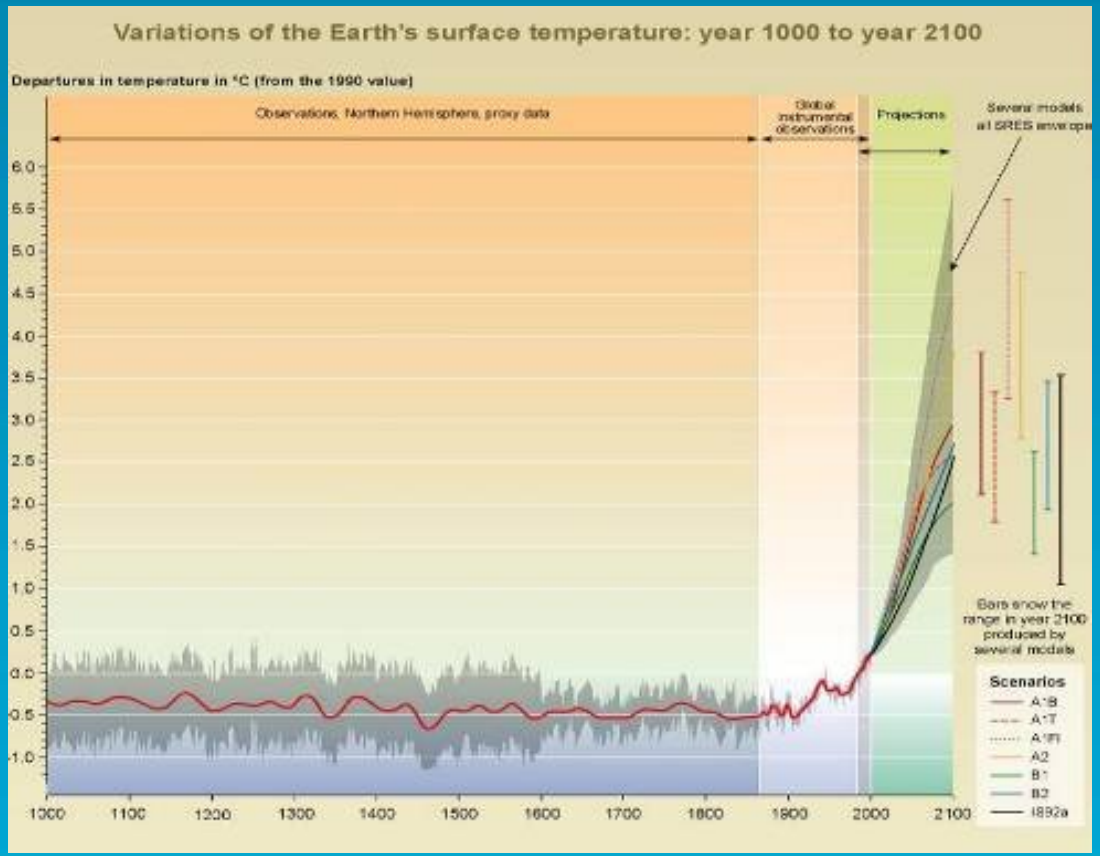
- **Adaptation – planning to adapt to the committed changes in climate**
- **Mitigation – actions to reduce future climate change**

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

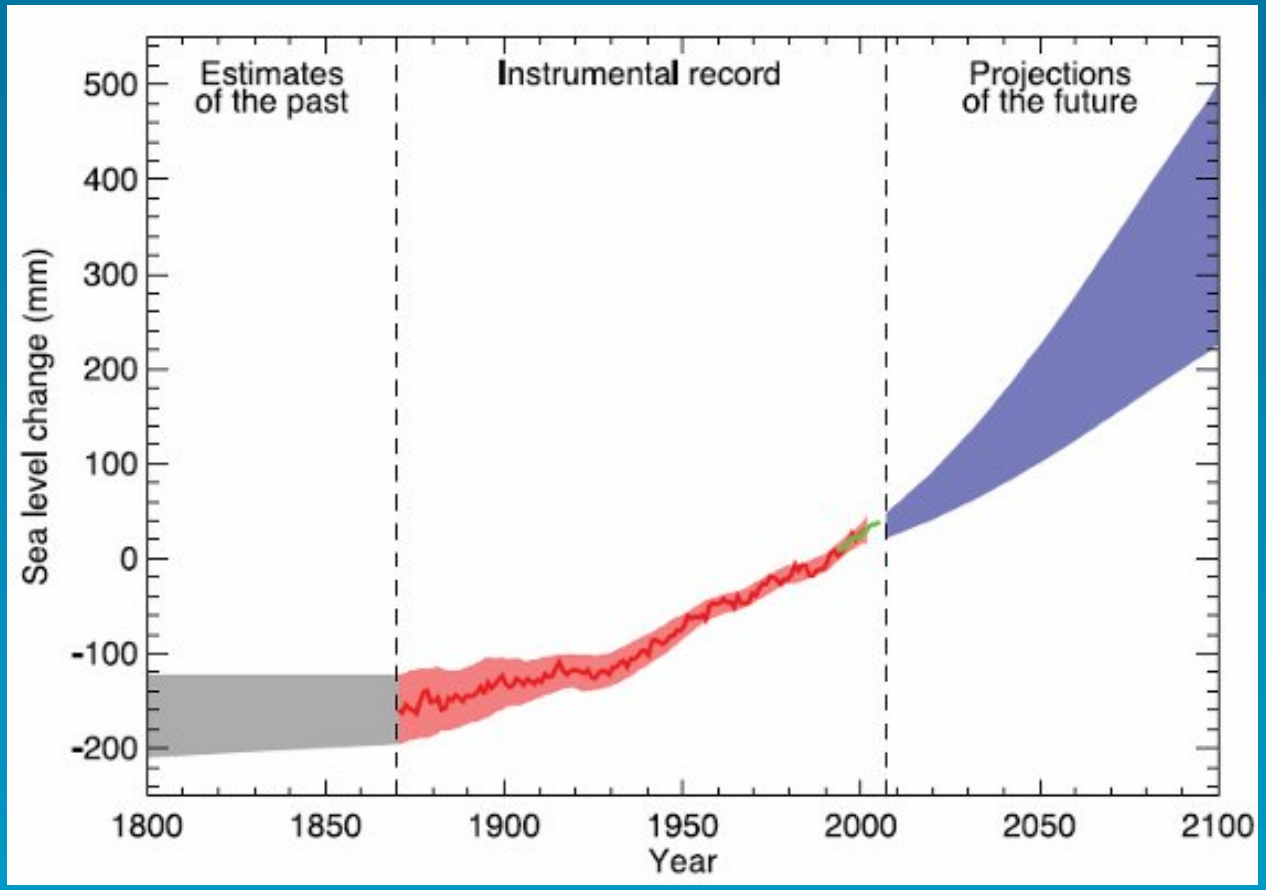
Climate Change Scenarios

- 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



Source: IPCC 4th Assess… 2007

Sea level rise

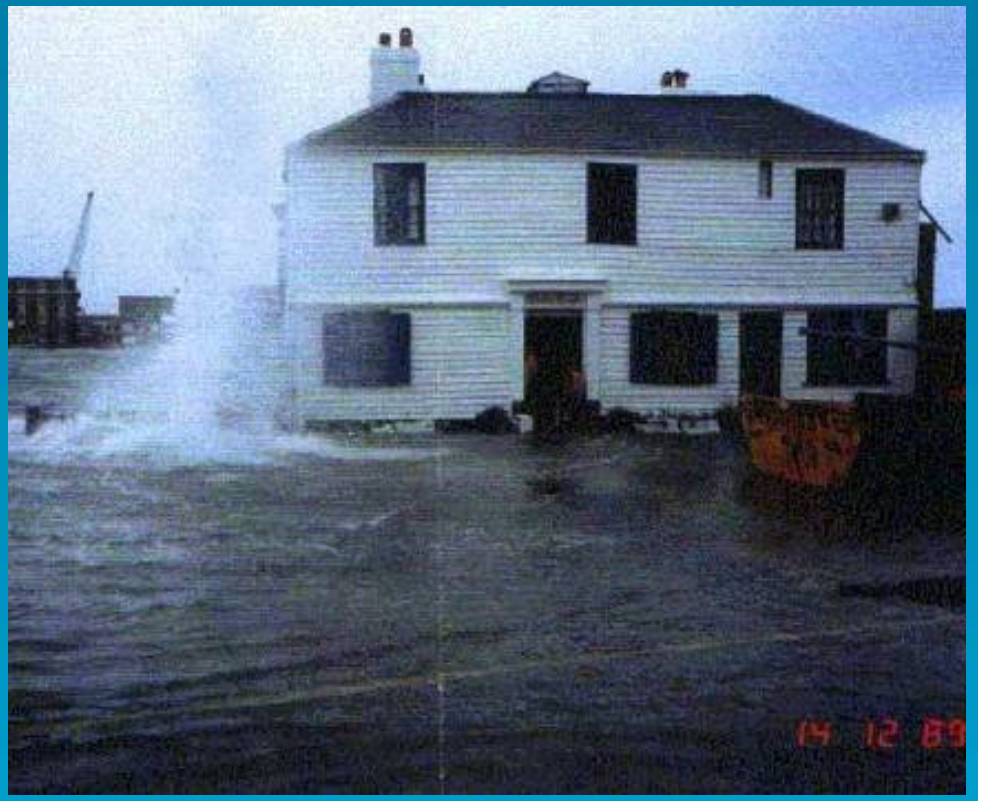


Source: IPCC 4th Assessment Report, 2007

- **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

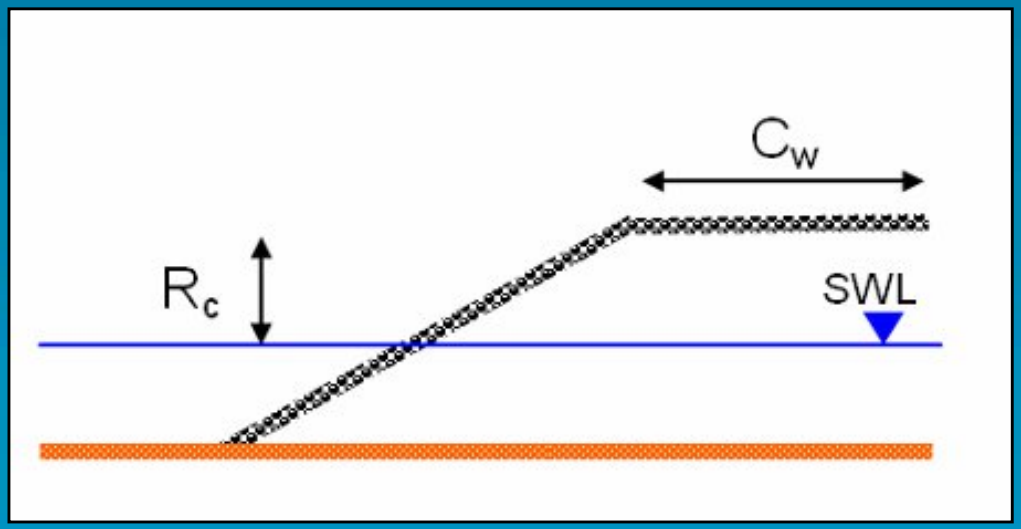
Climate Change Impact on Trade

- 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



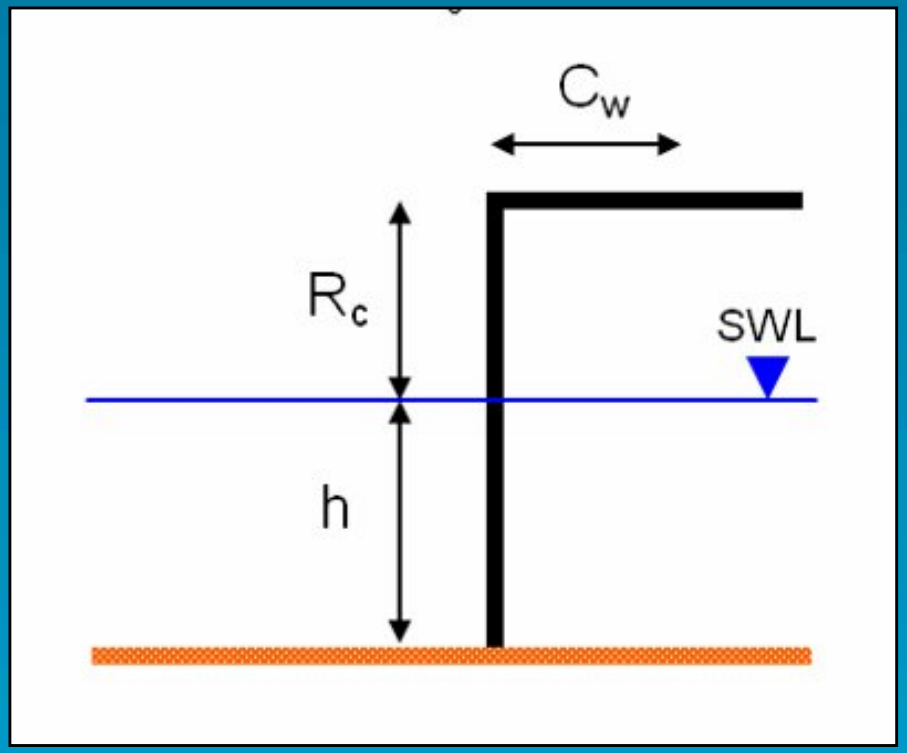
Breakwater overtopping

Water Level (ft)	Offshore Wave Height (ft)	Wave Period (s)	Crest Height (ft)	Overtopping	
				Volume (g/s/ft)	Percentage increase
0	6.5	8.5	5.9	175	-
5 in	6.5	8.5	5.9	194	11%
8 in	6.5	8.5	5.9	215	24%
12 in	6.5	8.5	5.9	227	31%
24 in	6.5	8.5	5.9	298	72%

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

Water Level	Offshore Wave Height (ft)	Wave Period (s)	Crest Height (ft)	Overtopping	
				Volume (g/s/ft)	Percentage increase
0	6.5	8.5	5.9	0.35	-
5 in	6.5	8.5	5.9	0.41	16%
8 in	6.5	8.5	5.9	0.47	35%
12 in	6.5	8.5	5.9	0.51	45%
24 in	6.5	8.5	5.9	0.74	112%

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

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Mobile, Alabama

AAPA Climate Change Wo

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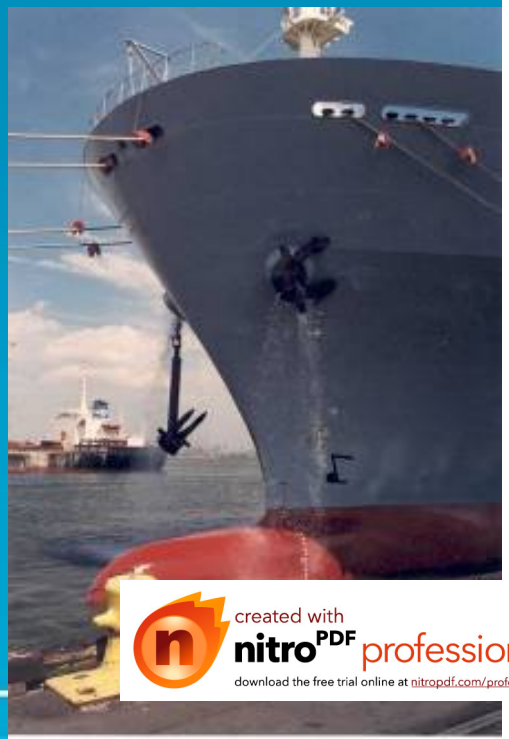
Implications for Channels

- 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

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Port Arthur Ship Canal, TX

- Effect on entrance channel/breakwaters?
- Change implication for channel access – currents/water levels
- Potential passing ship effects

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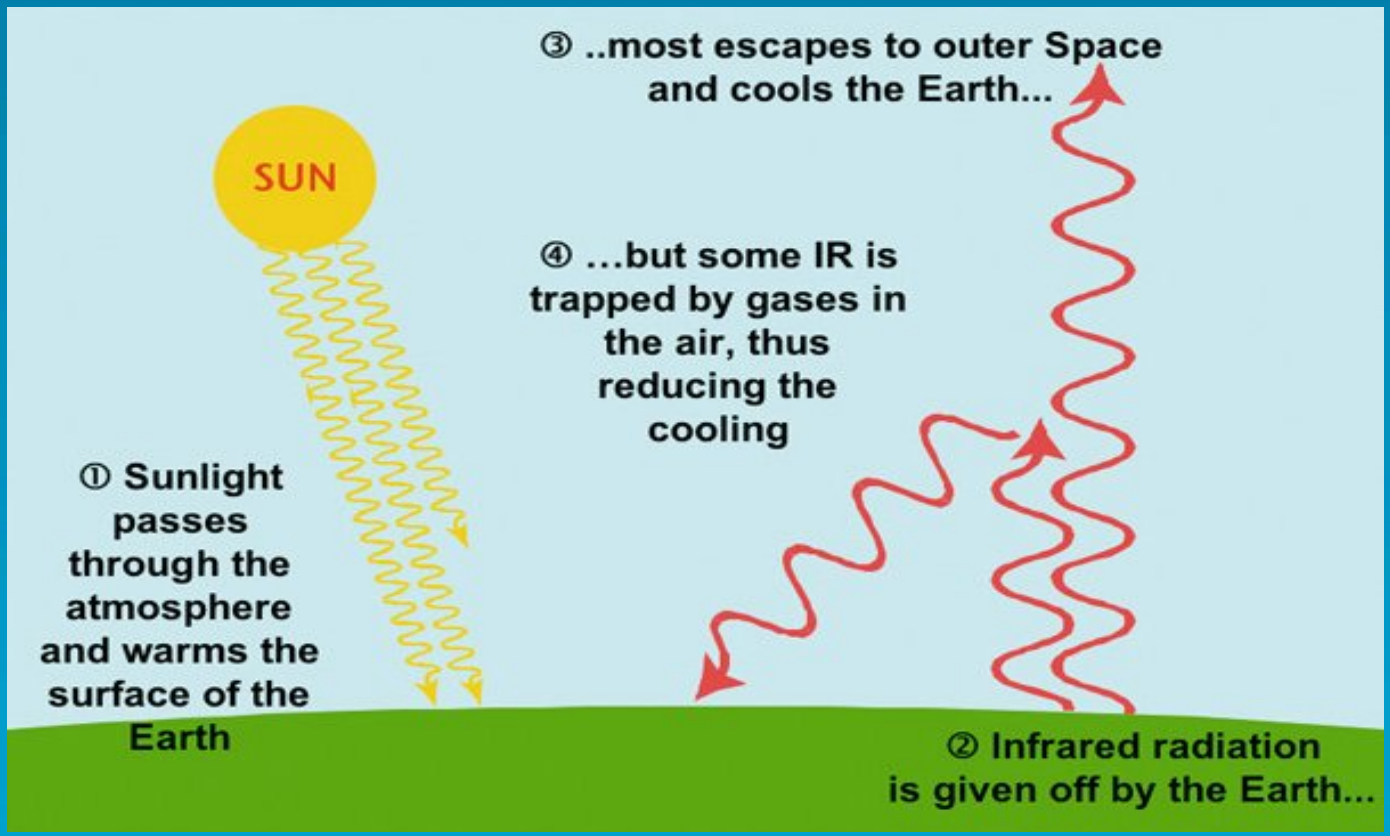
- Higher water levels will have implication for bridge clearances

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



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

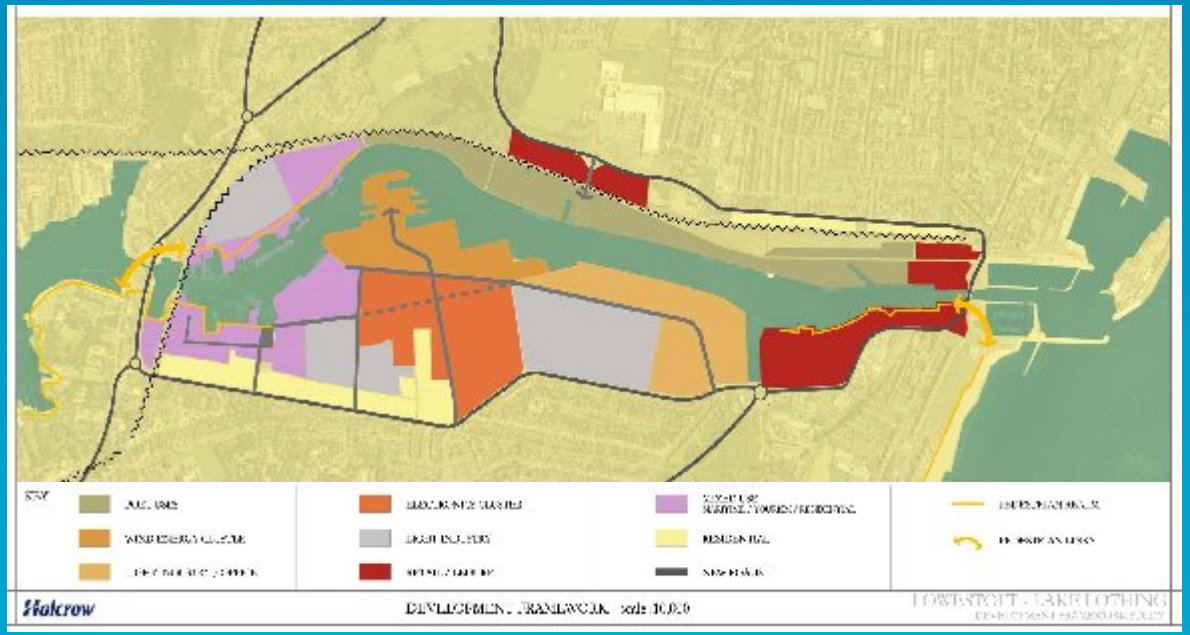
- Port of Oakland:
  - supply side capacity, infrastructure and cost issues. Mobile LNG generator demonstration project
- Port of Gothenburg (Sweden):
  - tax exemption for use of shoreside power = parity with costs of bunker fuel
- Port of Los Angeles and Port of Long Beach:
  - Co-operative effort 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



Summary

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

Conclusions

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

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Thank you

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