



Global Climate Change, Sea Level Rise, and Impact on Ports

Robert Massarelli, AICP



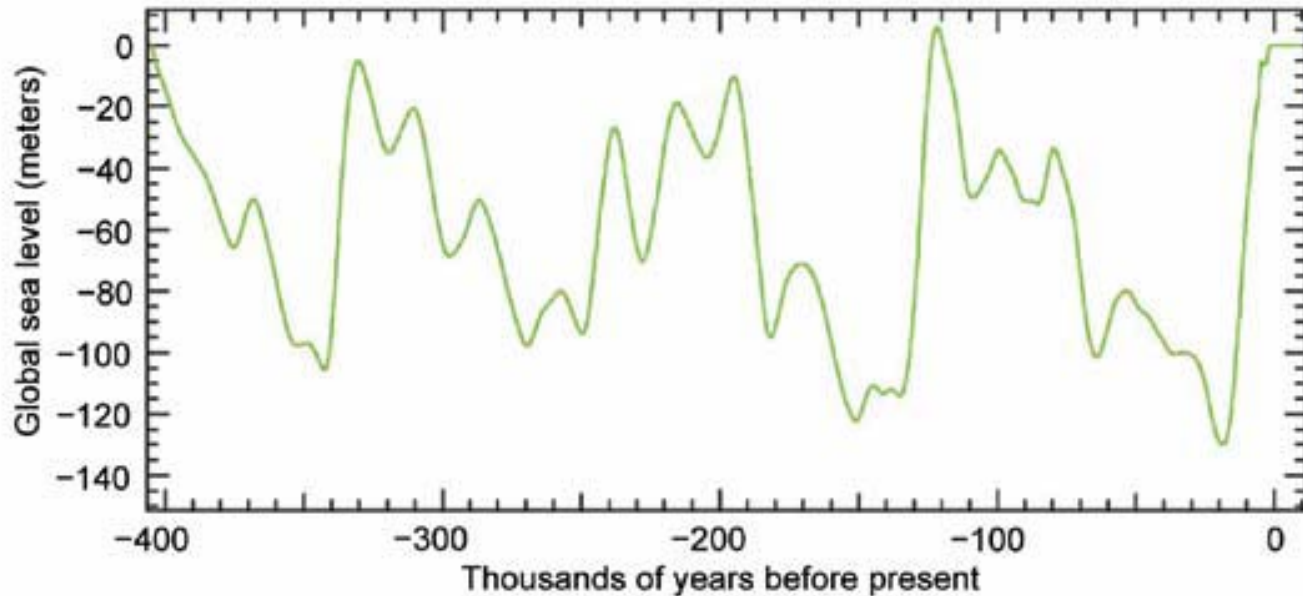
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- **Sea Level Rise**
- **Impacts**
- **Response**
- **Example**



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400,000 Years of Sea Level Elevations



U.S. Climate Change Science Program





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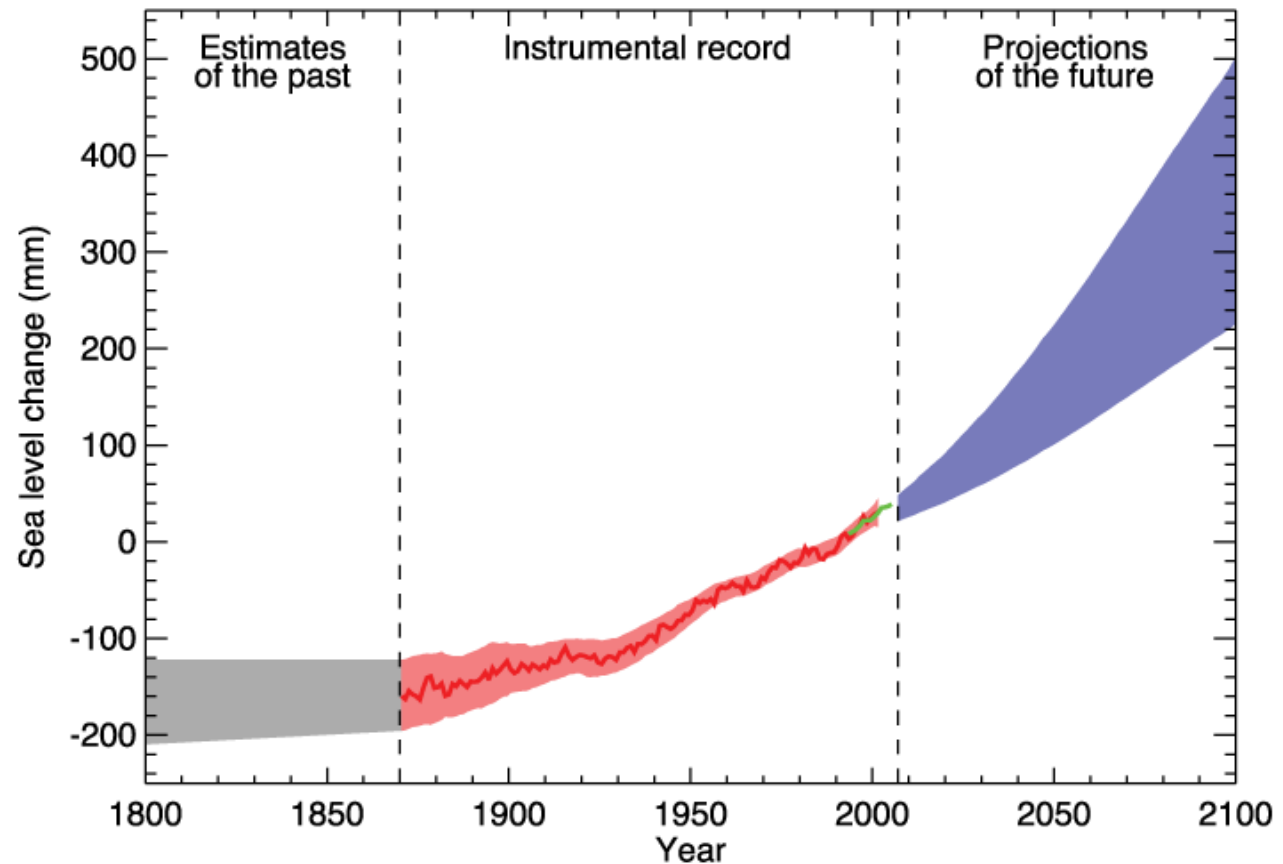
Challenges in Sea Level Rise Projections

- ❖ Tidal Components
- ❖ Barometric Pressure
- ❖ Meteorological Conditions
- ❖ Temperature
- ❖ Geological
- ❖ Changes in Reference Points
- ❖ Statistical Variation



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Sea Level Rise Projections





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Who is your audience?

- ❖ **Climate Change (man-made affects)**
- ❖ **Climate Change (natural affects)**
- ❖ **National Security**
- ❖ **Good Business**
- ❖ **Changing Market Conditions**
- ❖ **Theological Values**



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Impacts of Sea Level Rise

- ❖ Change in Water Levels
- ❖ Shoreline Retreat
- ❖ Storm Events
- ❖ Flooding
- ❖ Saltwater Intrusion
- ❖ Loss of Wetlands





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Change in Water Levels

- ❖ Impact on Infrastructure
- ❖ Impact on Environmental Restoration Projects
- ❖ Bridge Clearance
- ❖ Changes in Sedimentation Patterns





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Shoreline Retreat

- ❖ Coastal Erosion
- ❖ Damage to bridges, wharfs, piers, terminals, ships, and cargo
- ❖ Damage to cranes, lighting systems, and other infrastructure





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Storm Events

- ❖ **Expanded Stormwater Treatment Facilities**
- ❖ **Higher Tailwater Elevations**





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Flooding

- ❖ Higher Frequency
- ❖ Higher Stages





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Saltwater Intrusion

- ❖ **Changes in Estuary Habitat**
- ❖ **Reduction of Fresh Groundwater**
- ❖ **Changes in Vegetation**





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Loss of Wetlands

- ❖ Flood Protection
- ❖ Habitat
- ❖ Environmental Restoration





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Responses

- ❖ Protection
- ❖ Retreat
- ❖ Accommodate
- ❖ Mitigate





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Protection

- ❖ Levees
- ❖ Beakwaters
- ❖ Flood Gates
- ❖ Raising Structures
- ❖ Beach Renourishment





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Retreat

- ❖ Relocating to a Higher Location
- ❖ Expanding Less Vulnerable Sites
- ❖ Land Use Planning





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Accommodate

- ❖ **Designs Standards**
- ❖ **Risk Analysis**
- ❖ **Desalinate Groundwater**
- ❖ **Salt Tolerate Vegetation**
- ❖ **Flood Proofing**





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Mitigate

- ❖ **Reduce Green House Gases**





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UK Department for Transport

- ❖ **Ports: National Policy Statement for England & Wales – Appraisal of Sustainability (AoS) Report**



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PORT OF ANTWERP

- ❖ **Shore-based Electricity Supply**
- ❖ **Using Dredging Spoil in Landscaping Dikes**
- ❖ **The Port More Naturally**





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PORT OF ROTTERDAM

- ❖ Rotterdam Climate Initiative (RCI)
- ❖ Rotterdam Climate Proof (RCP)

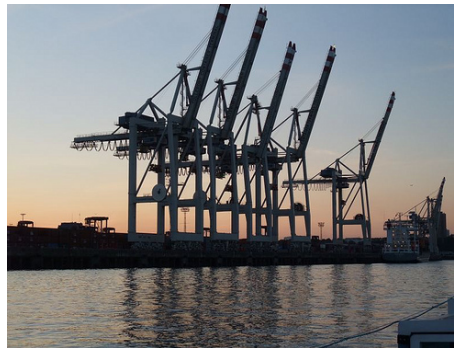




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Container Terminal Tollerort

- ❖ **Waste Heat is Recovered From the Treatment Process and Used To Heat the New Office Buildings**





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City of Oslo Port Authority

- ❖ **Windmills**
- ❖ **Waterfront Redevelopment**





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World Ports Climate Initiative

- ❖ **Fifty-five of the world's key ports**



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World Ports Climate Initiative

- ❖ Carbon Foot Printing
- ❖ Lease Agreement Template
- ❖ On-shore Power Supply



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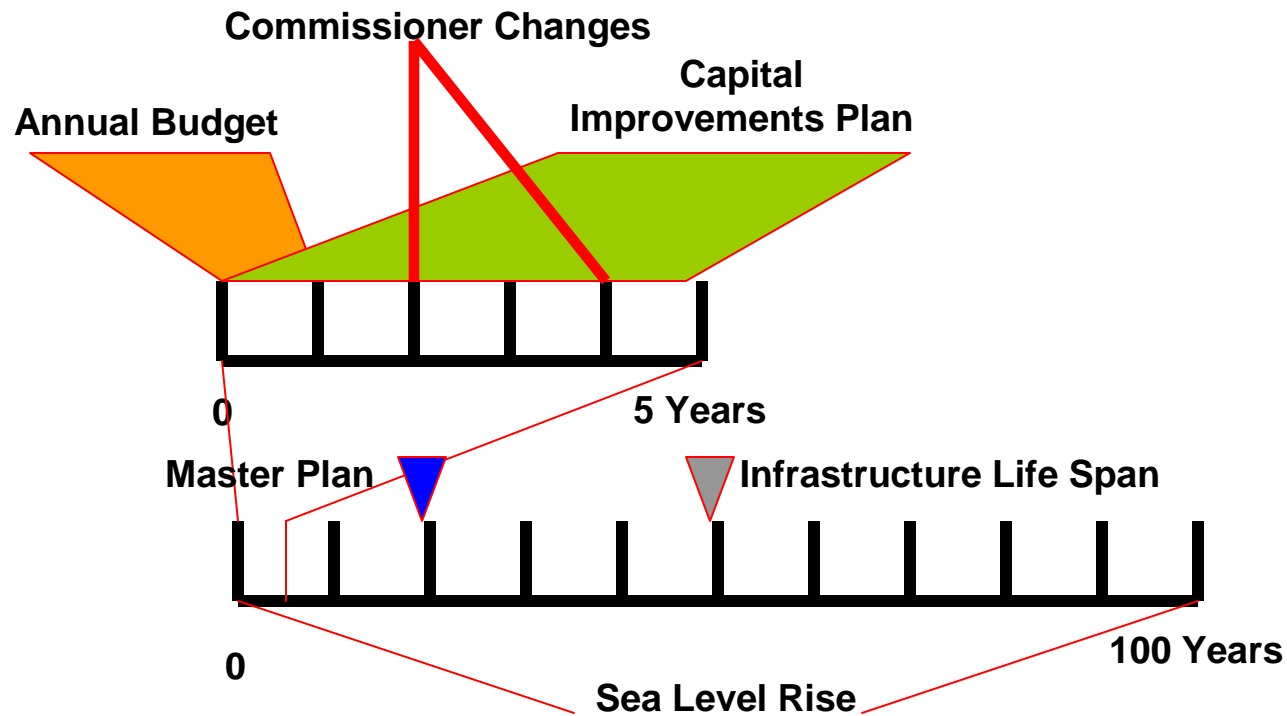
EcoPorts

- ❖ **Environmental Review 2009**
- ❖ **PEARL 2005-2008**
- ❖ **Econet**
- ❖ **Eco-Information**



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Conclusion





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Conclusion

- 1. Incorporate climate change forecasts into short- and long-term plans, to the extent possible**

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Conclusion

2. **Keep abreast of developments in climate science and adaptation to climate change**

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Conclusion

- 3. Reach out to other agencies to form alliances to address means of adapting to climate change**

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4. **Study the actions that other ports are taking to prepare for climate change**

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- 5. A national study focused on ports' risk from climate change and their adaptation options could be useful**

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Thank You

Questions?