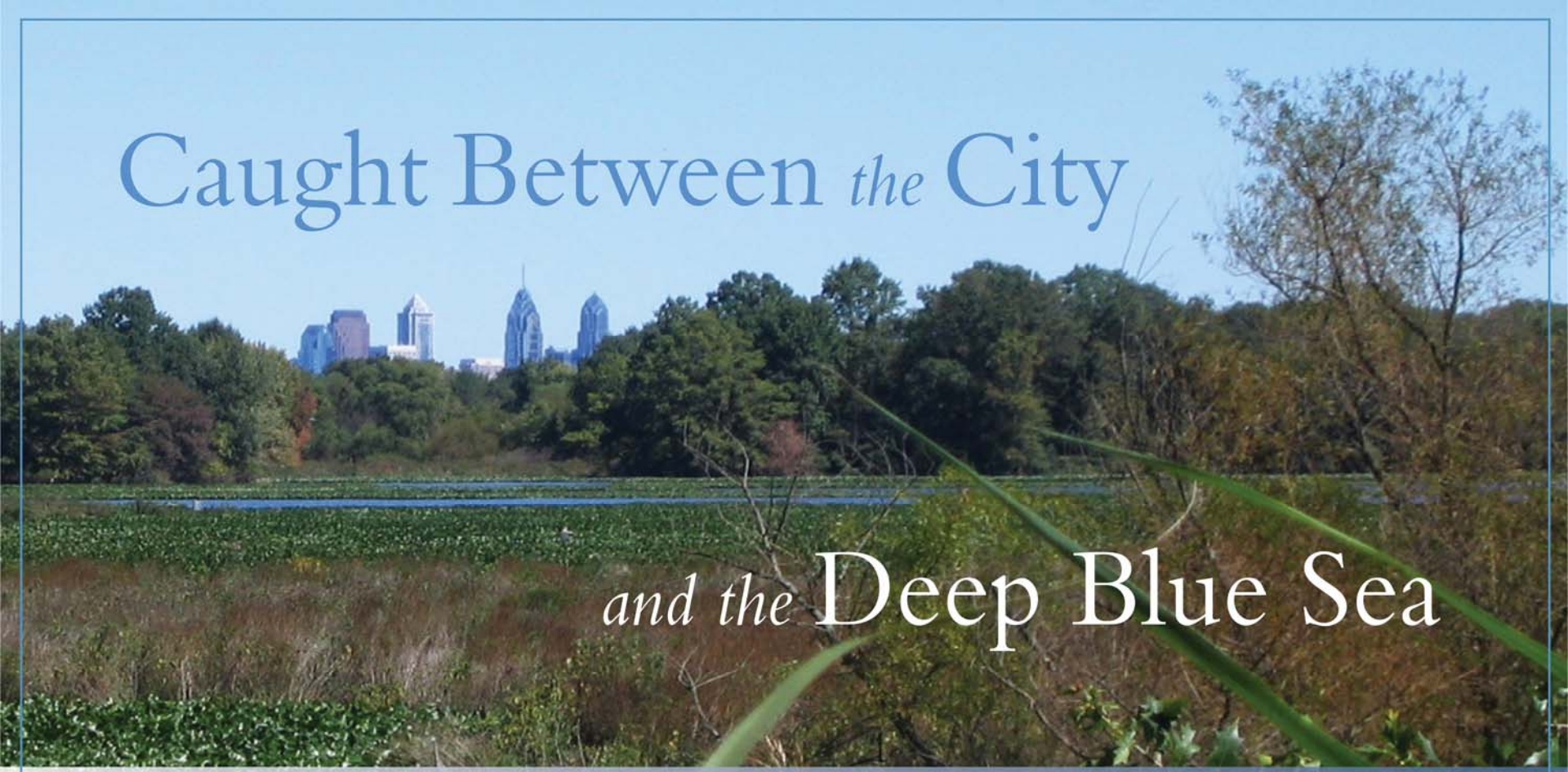

Sea Level Rise – Looking Forward and Planning Now

January 13th, 2010

Presented by Chris Linn

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

IOP PUBLISHING ENVIRONMENTAL RESEARCH LETTERS
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State and local governments plan for development of most land vulnerable to rising sea level along the US Atlantic coast*

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Abstract
Rising sea level threatens existing coastal wetlands. Overall ecosystems could often survive by migrating inland, if adjacent lands remained vacant. On the basis of 131 state and local land use plans, we estimate that almost 60% of the land below 1 m along the US Atlantic coast is expected to be developed and thus unavailable for the inland migration of wetlands. Less than 10% of the land below 1 m has been set aside for conservation. Environmental

Area at risk of inundation from 1-meter (3.3 ft.) rise in sea level

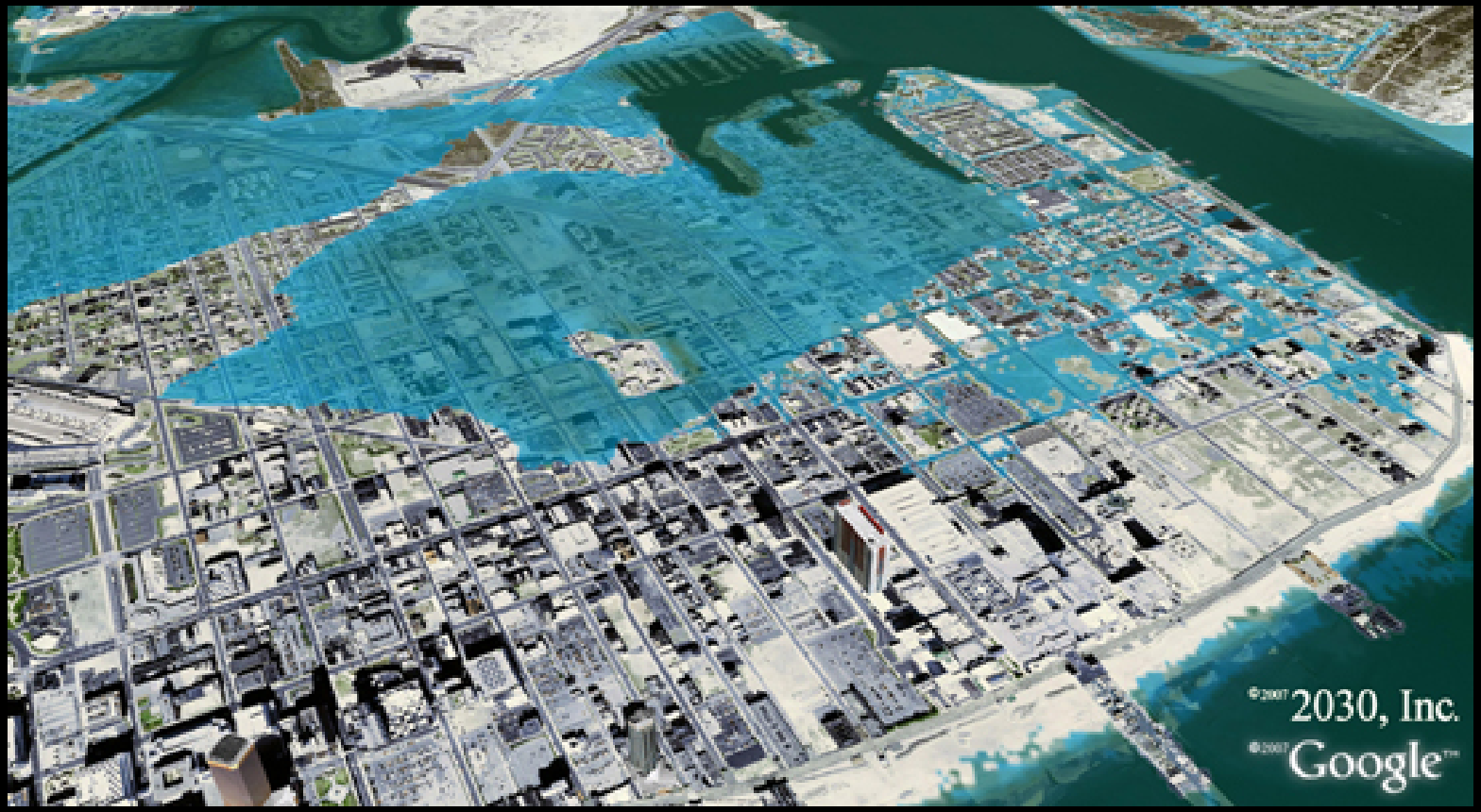
- Current sea level
- Low estimate
- Central estimate
- High estimate

Elevations based on computer models, not actual surveys. High, central, and low estimates indicate amount of land potentially inundated. Range in estimates reflects uncertainty in underlying elevation model. Inundation shown does not reflect coastal protection efforts that may prevent some low-lying areas from being flooded as sea level rises. Map does not depict inland areas below modeled sea level where not connected directly to the sea. Some hydraulically isolated areas that are below the predicted rise in sea level may become inundated as water tables rise.

CLEAN AIR COOL PLANET

Prepared by Stratus Consulting Inc.
Elevation and wetland data: US EPA, 2008
Imagery: USGS, 2002; DVRPC, 2005

Atlantic City, NJ



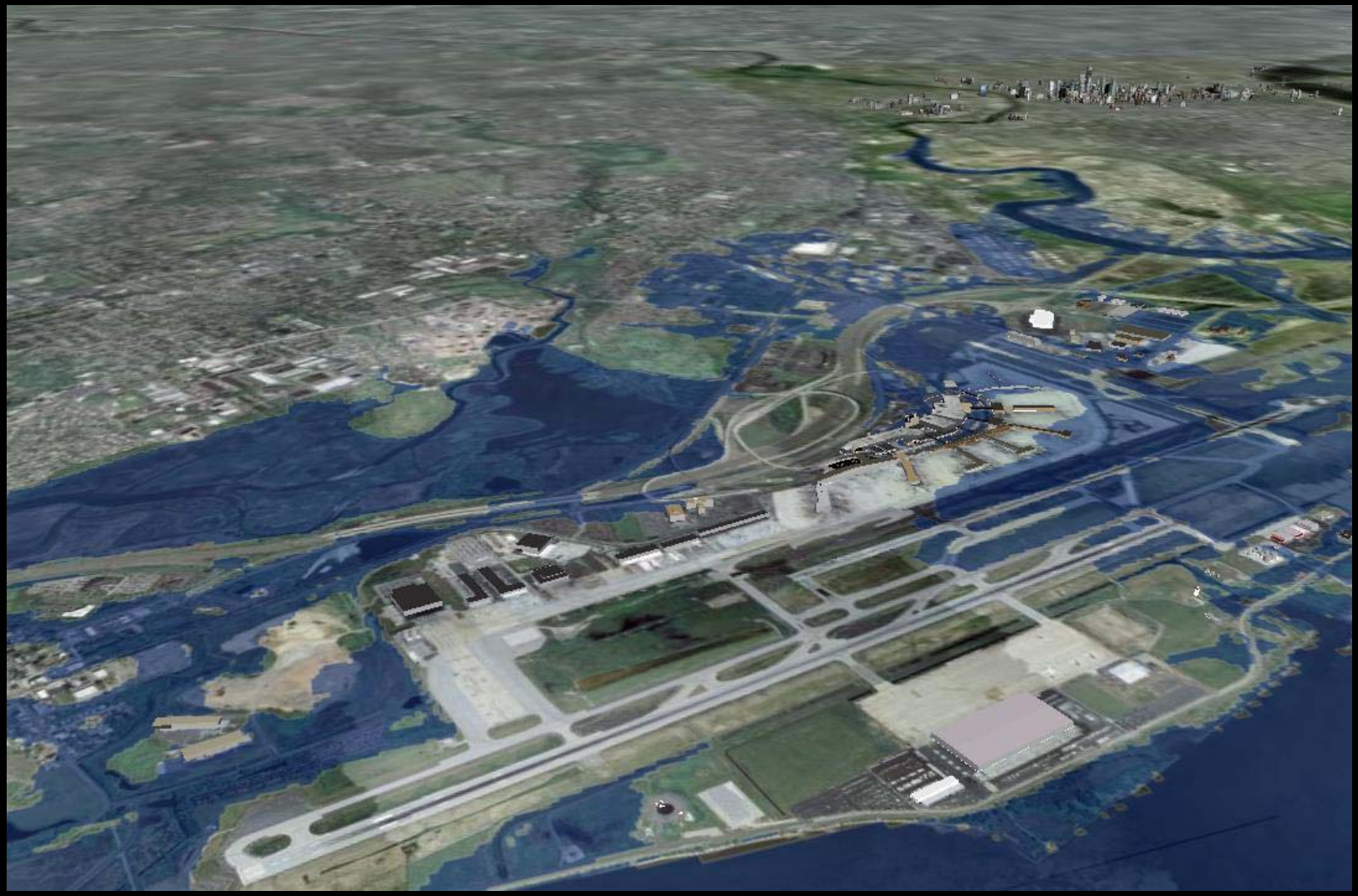
Philadelphia International Airport and Heinz Wildlife Refuge

Current Sea Level

Slide courtesy of University of Pennsylvania Climate Change Studio

Philadelphia International Airport and Heinz Wildlife Refuge

2100 Sea Level



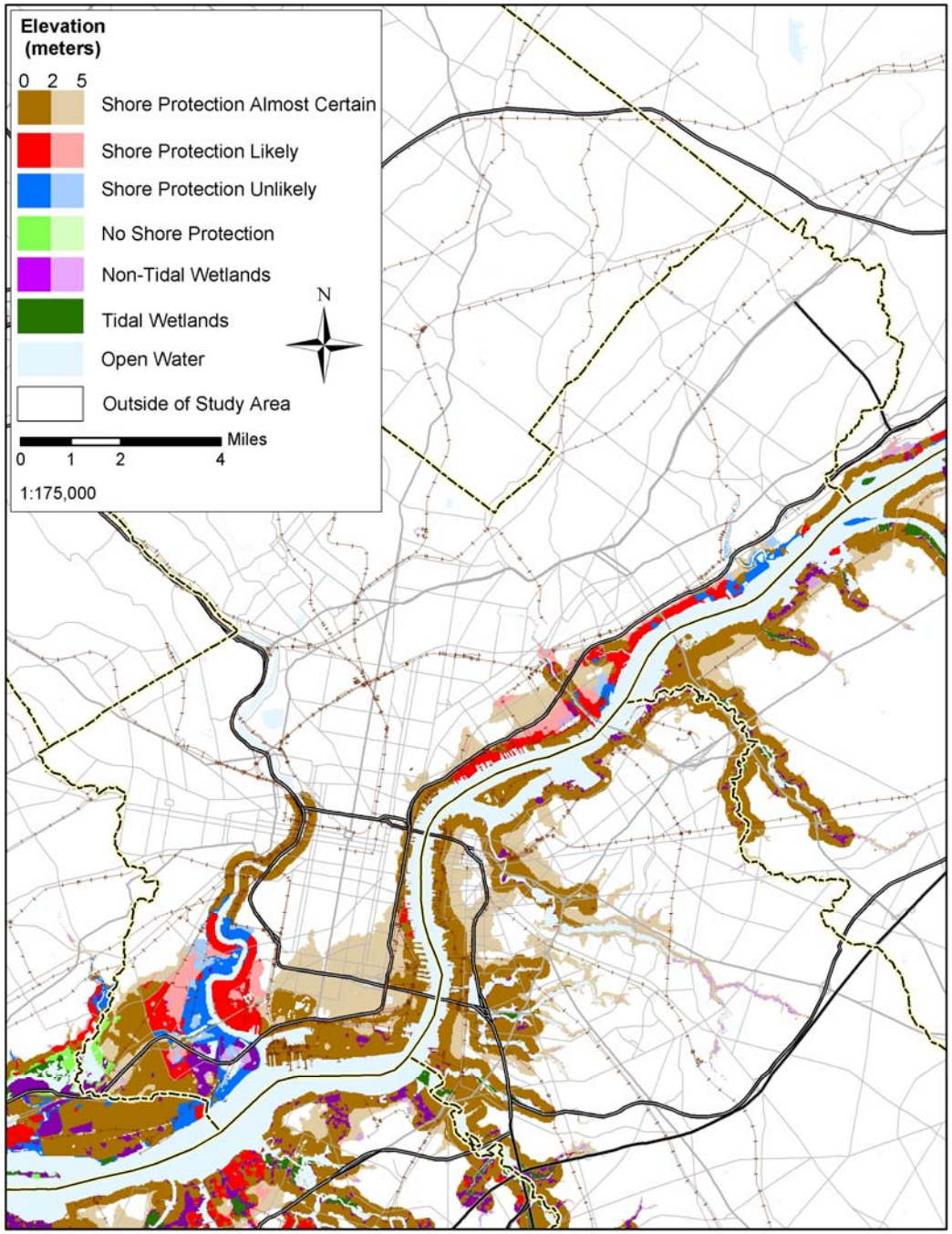
Slide courtesy of University of Pennsylvania Climate Change Studio

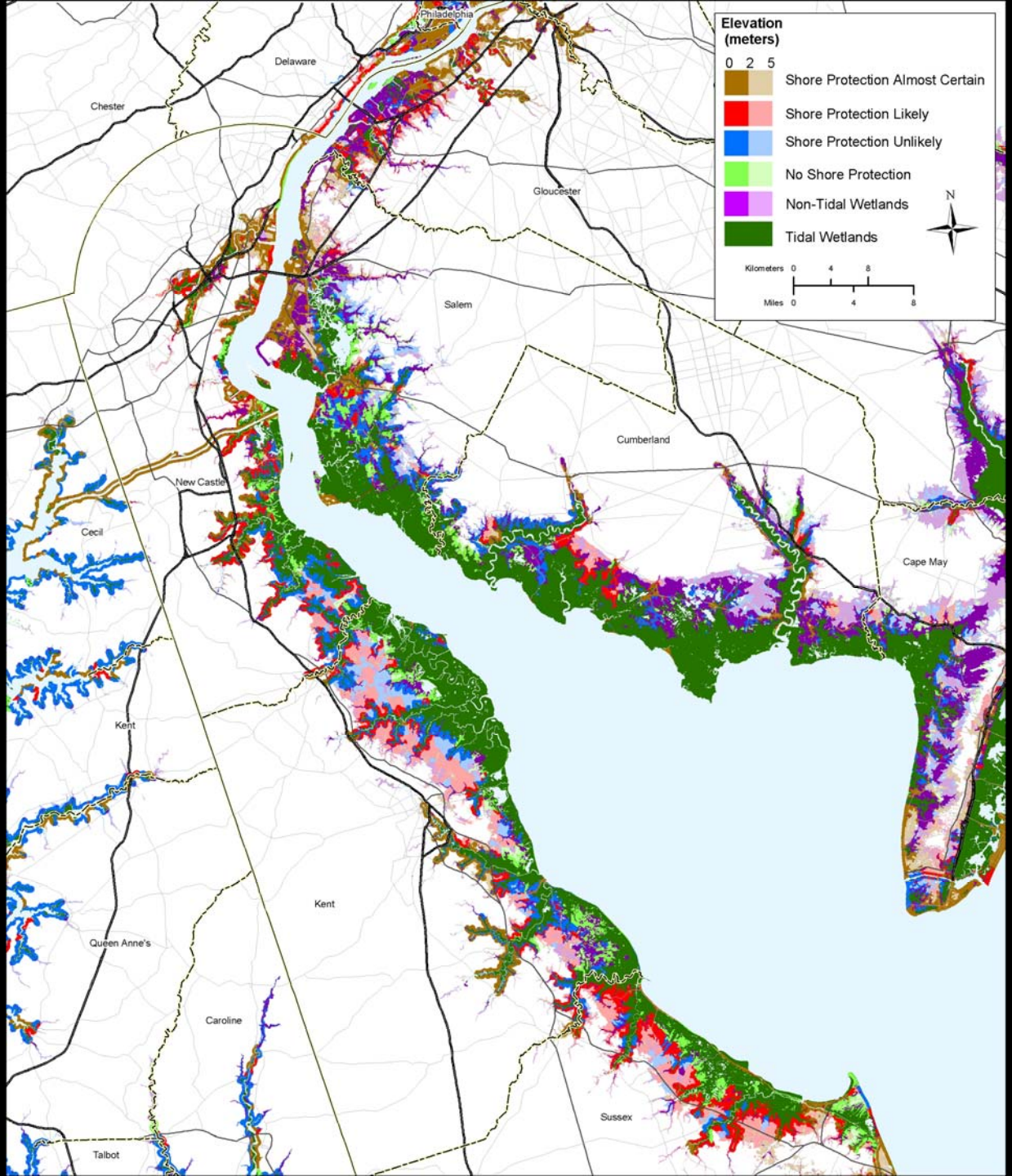
Shore Protection Study

- Analyzed 131 state and local land use plans
- Shoreline protection estimates based on:
  - Current development patterns
  - Interviews with local planners and officials
  - Existing state and federal policies
- Four protection categories defined
  - Almost certain
  - Likely
  - Unlikely
  - No shore protection – conservation lands

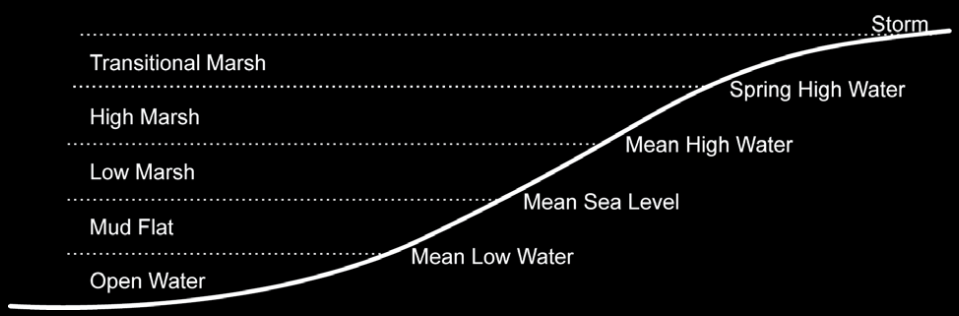
PENNSYLVANIA SEA LEVEL RISE PLANNING MAPS

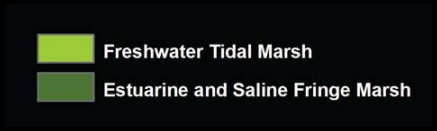
County: Philadelphia




Elevation
(meters)
0 2 5
Shore Protection Almost Certain
Shore Protection Likely
Shore Protection Unlikely
No Shore Protection
Non-Tidal Wetlands
Tidal Wetlands
N
Kilometers 0 4 8
Miles 0 4 8
Philadelphia
Delaware
Chester
Gloucester
Salem
Cumberland
New Castle
Cecil
Cape May
Kent
Kent
Queen Anne's
Caroline
Sussex
Talbot

Delaware Estuary Tidal Wetlands

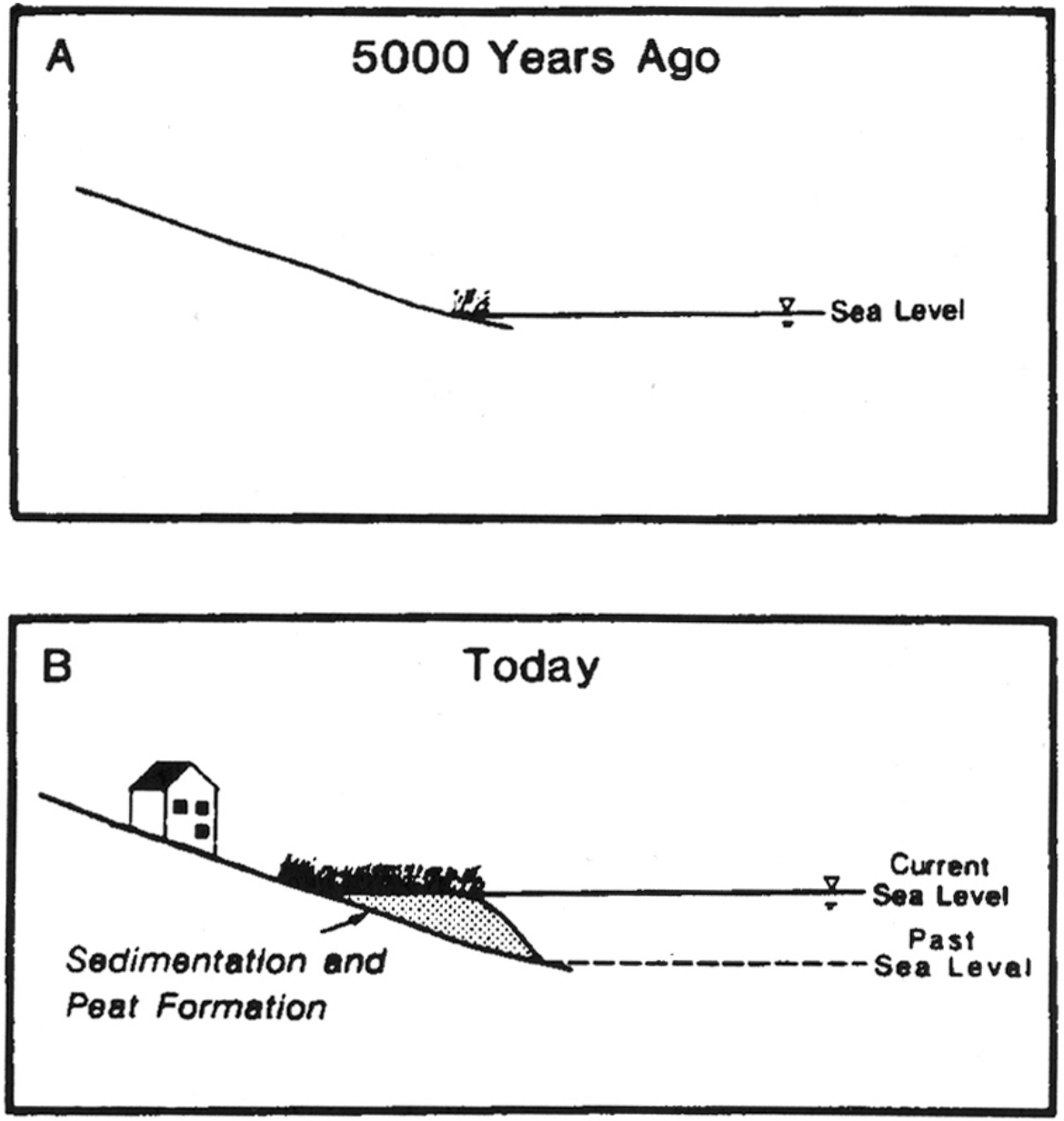




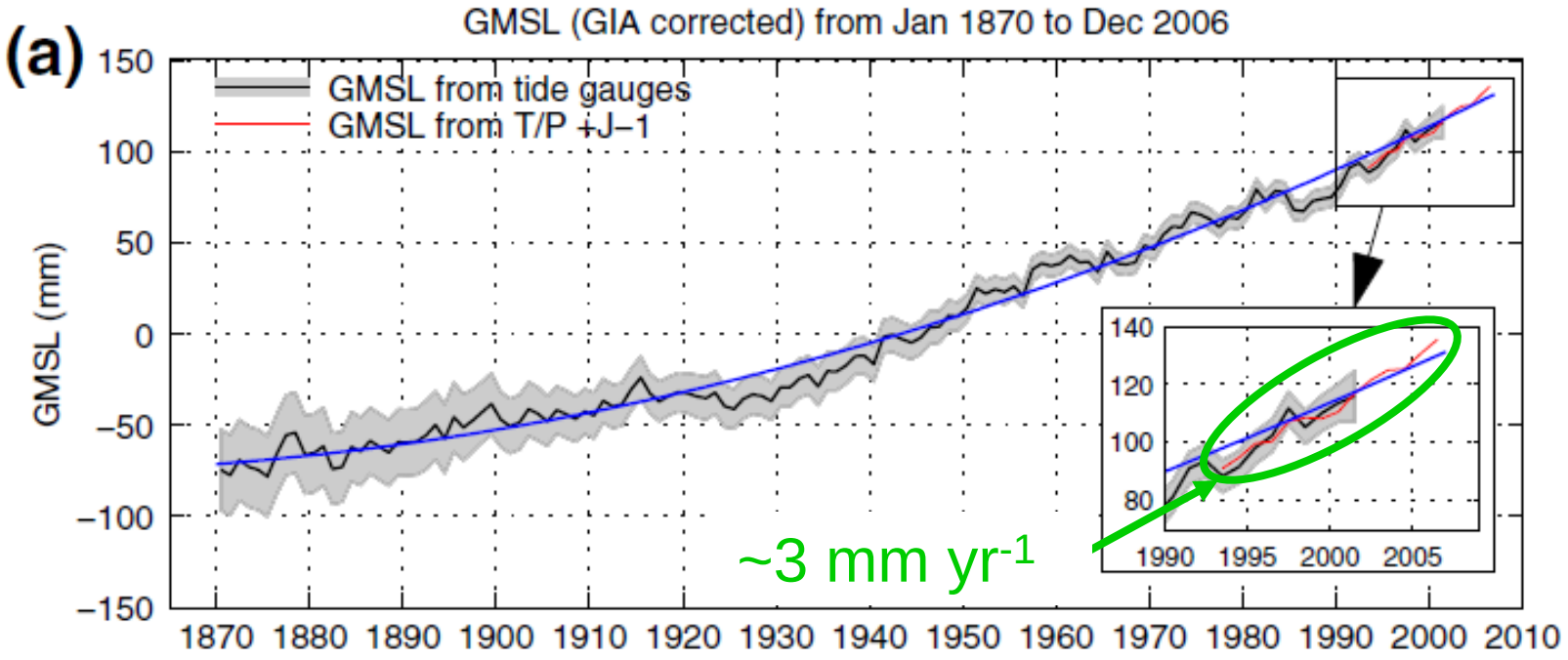
Slide courtesy of University of Pennsylvania Climate Change Studio

Tidal Wetlands Impacts

- Tidal wetland responses to sea level rise:
  - Upward growth through accretion
  - Migrate inland to adjacent uplands – i.e., transgression
  - Conversion to open water


A
5000 Years Ago
Sea Level
B
Today
Current
Sea Level
Past
Sea Level
Sedimentation and
Peat Formation

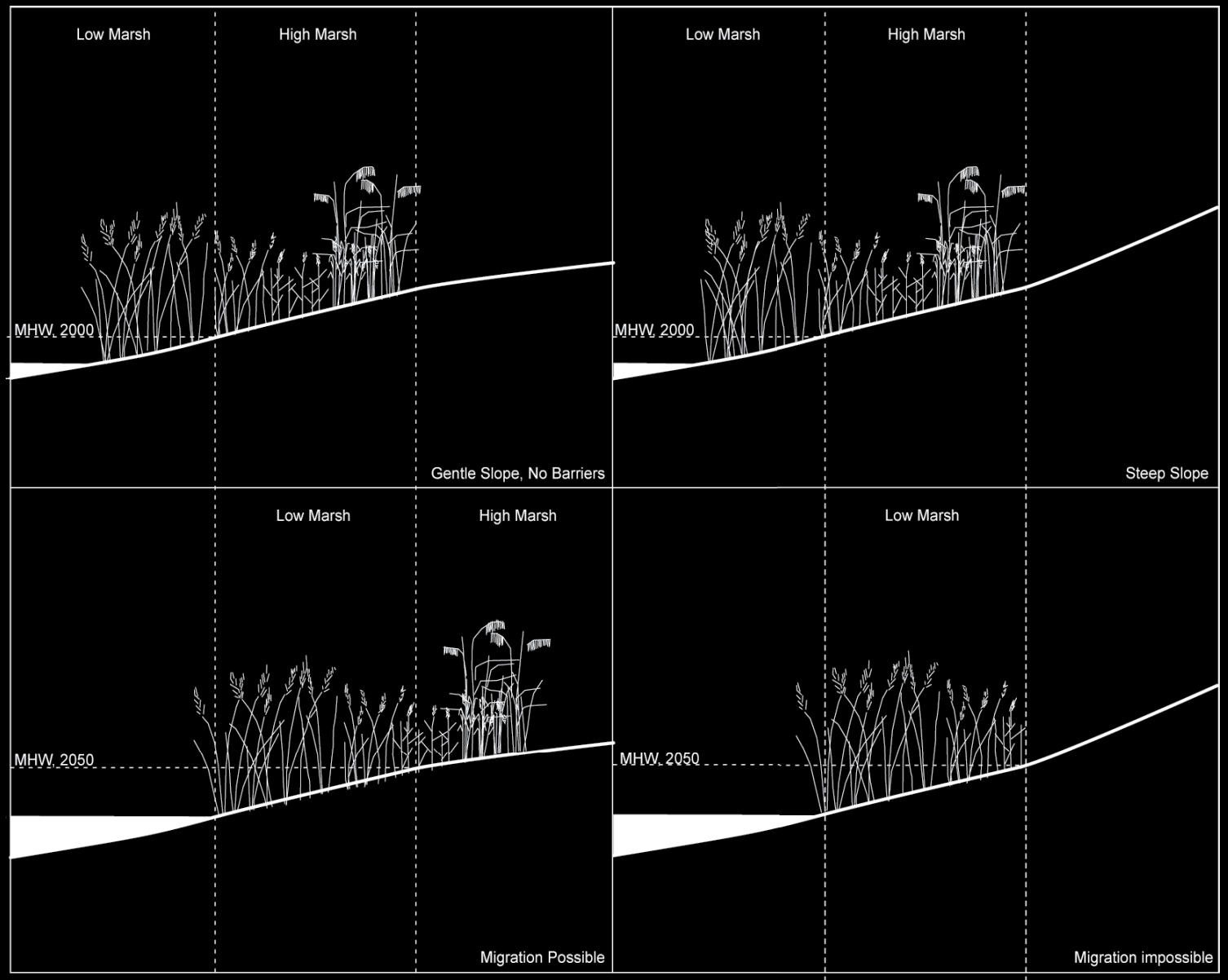
Global changes—last century



The rate of global mean sea level (GMSL) rise is variable, but overall has increased over the past 140 years. Most recent 20-year trends are ~3 mm yr^{-1}. Closing the sea-level budget is an active area of research.

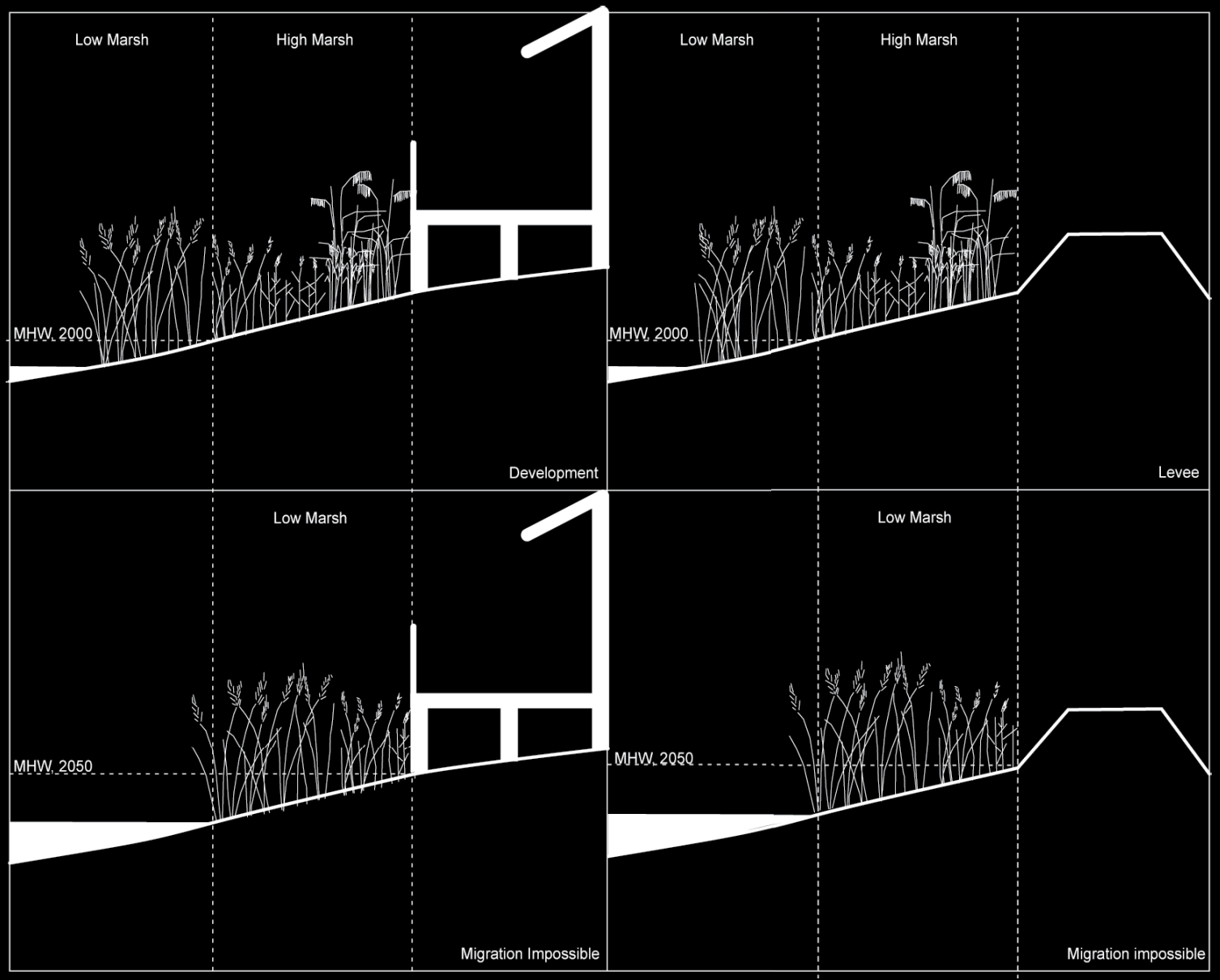
Source: Church et al. (2008) -- Slide courtesy of Ray Najjar, Pennsylvania State University

Wetlands - Analysis: Marsh Transgression



Slide courtesy of University of Pennsylvania Climate Change Studio

Wetlands - Analysis: Marsh Loss



Slide courtesy of University of Pennsylvania Climate Change Studio

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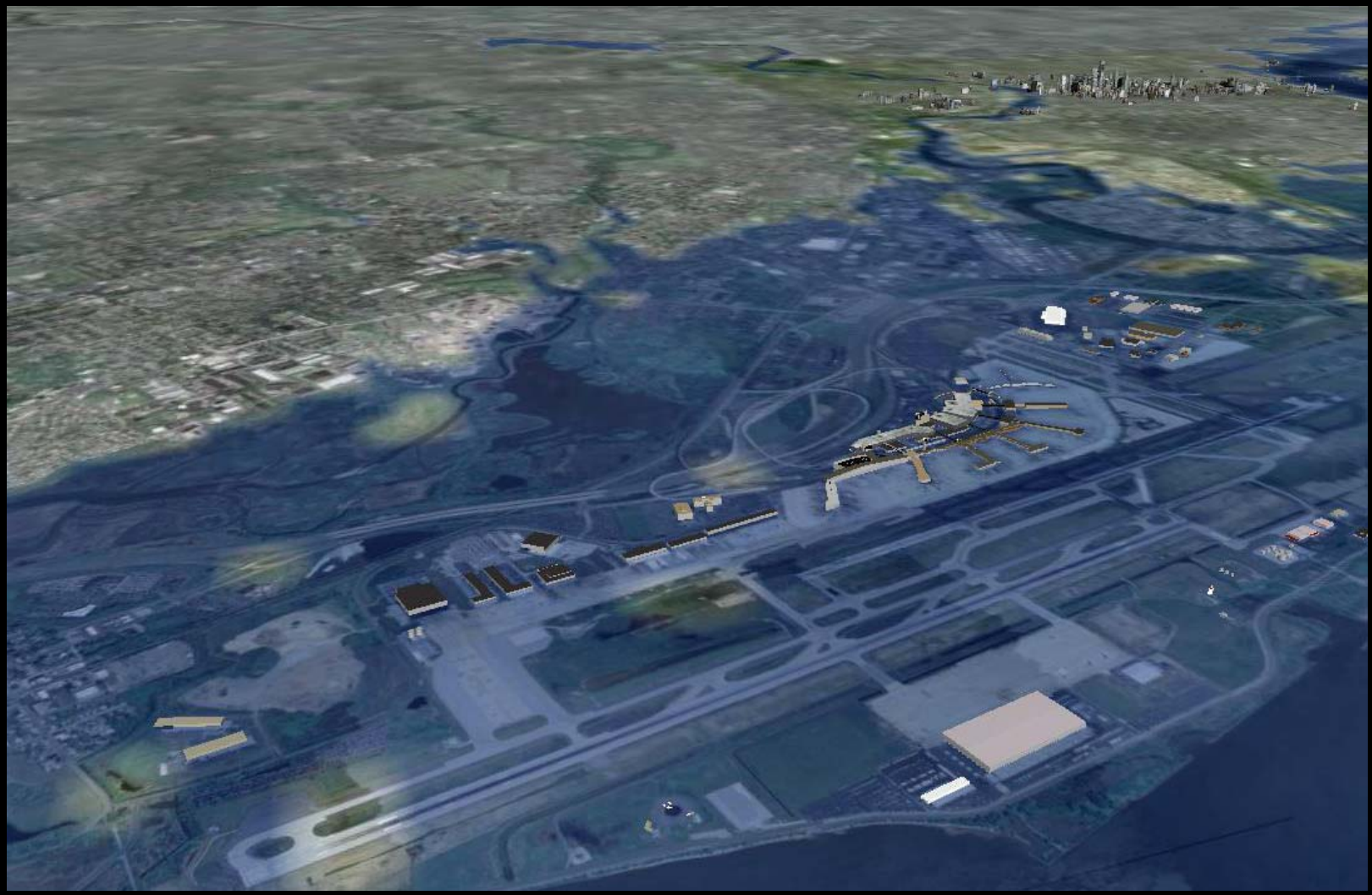
Future

Complete Wetland Loss Where House is Protected In Response to Rise in Sea Level

Philadelphia Airport and Heinz Wildlife Refuge Today

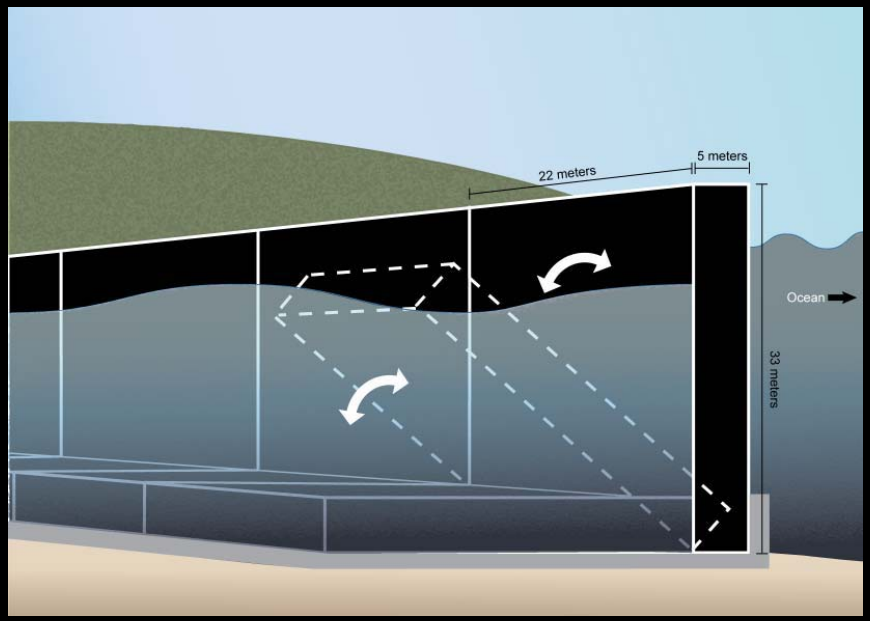
Storm Surge Threat Today



Storm Surge of Approximately 10 feet

Slide courtesy of University of Pennsylvania Climate Change Studio

Hydraulic Flap Gate Storm Surge Barrier



Proposed disappearing oscillating flap gate

Can lie flat on river bottom unless needed, minimal interference with navigation , normal river flows, minimal disruption to lives of river plant and animal species.

Like all movable barriers, requires monthly maintenance

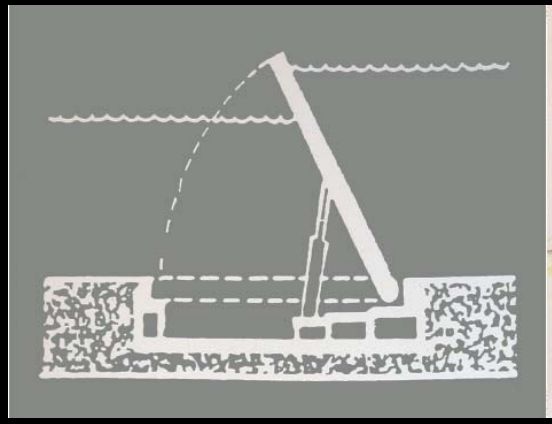
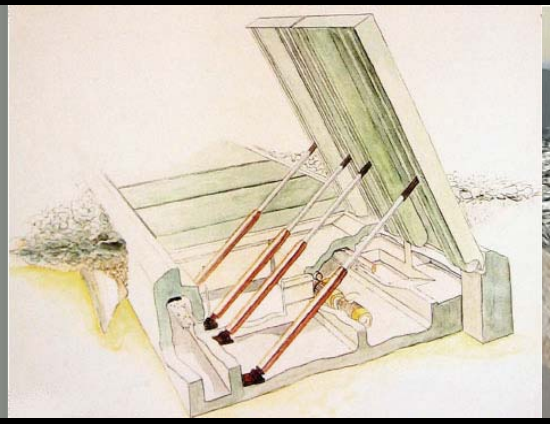
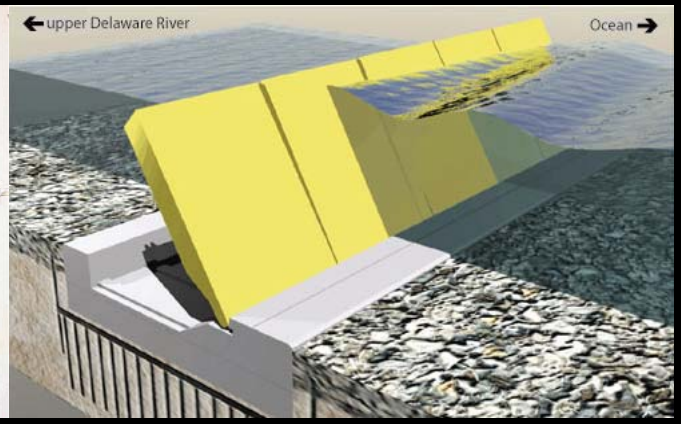


Diagram of proposed hydraulic barrier for Netherlands



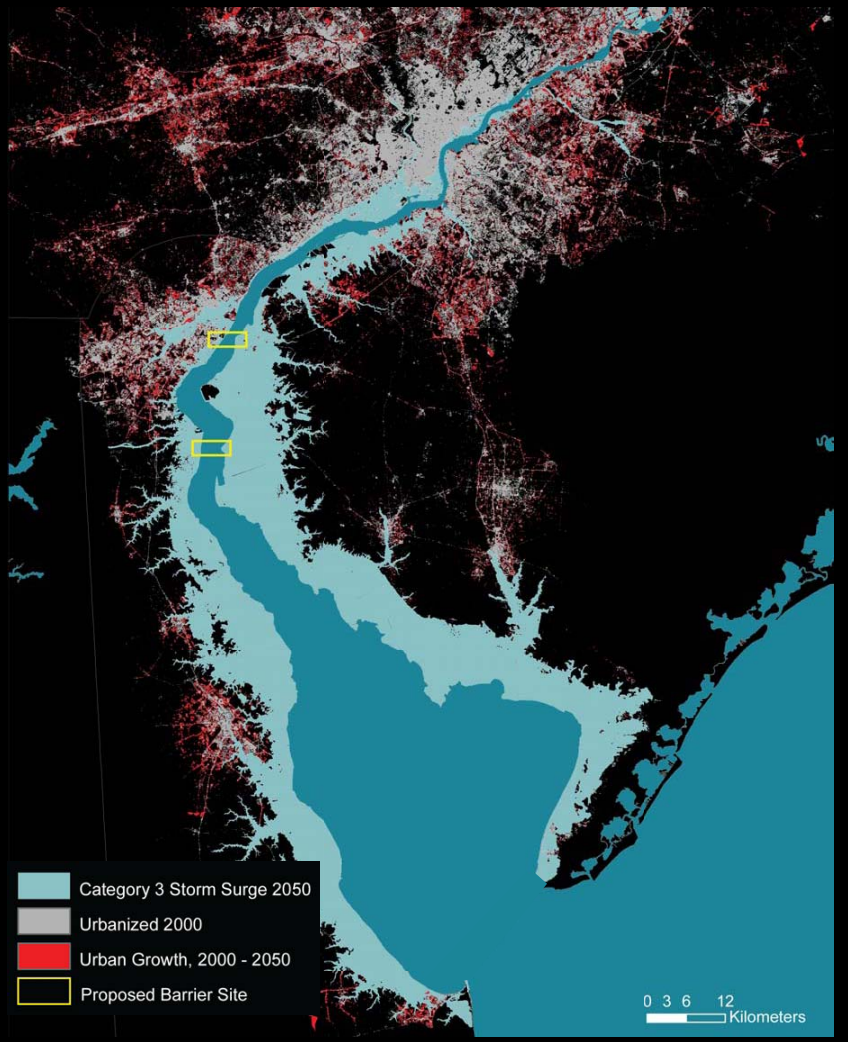
Proposed hydraulic barrier for Netherlands



Proposed mobile gates for Venice (www.pbs.org)

Slide courtesy of University of Pennsylvania Climate Change Studio

Storm Surge Barrier – Preferred Alternative



Slide courtesy of University of Pennsylvania Climate Change Studio

Adaptation Strategies

- Existing wetland regulatory programs
- Local planning and decision making
- Better support tools for planning
  - Nature Conservancy's Coastal Resilience Project
- NOAA Coastal Services Center and PA Sea Grant Workshop
  - Adapting to coastal hazard and climate threats in the Philadelphia area

Sea Level Rise and Wetlands

- Wetland migration will be blocked by existing development and shoreline armoring
- Wetland regulations protect wetlands from human activities, but not from sea level rise
- Sea level rise, wetland migration, and protection of communities from coastal hazards need to be integrated into local planning and decision making to minimize adverse impacts to human and natural communities

Questions?

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Senior Environmental Planner
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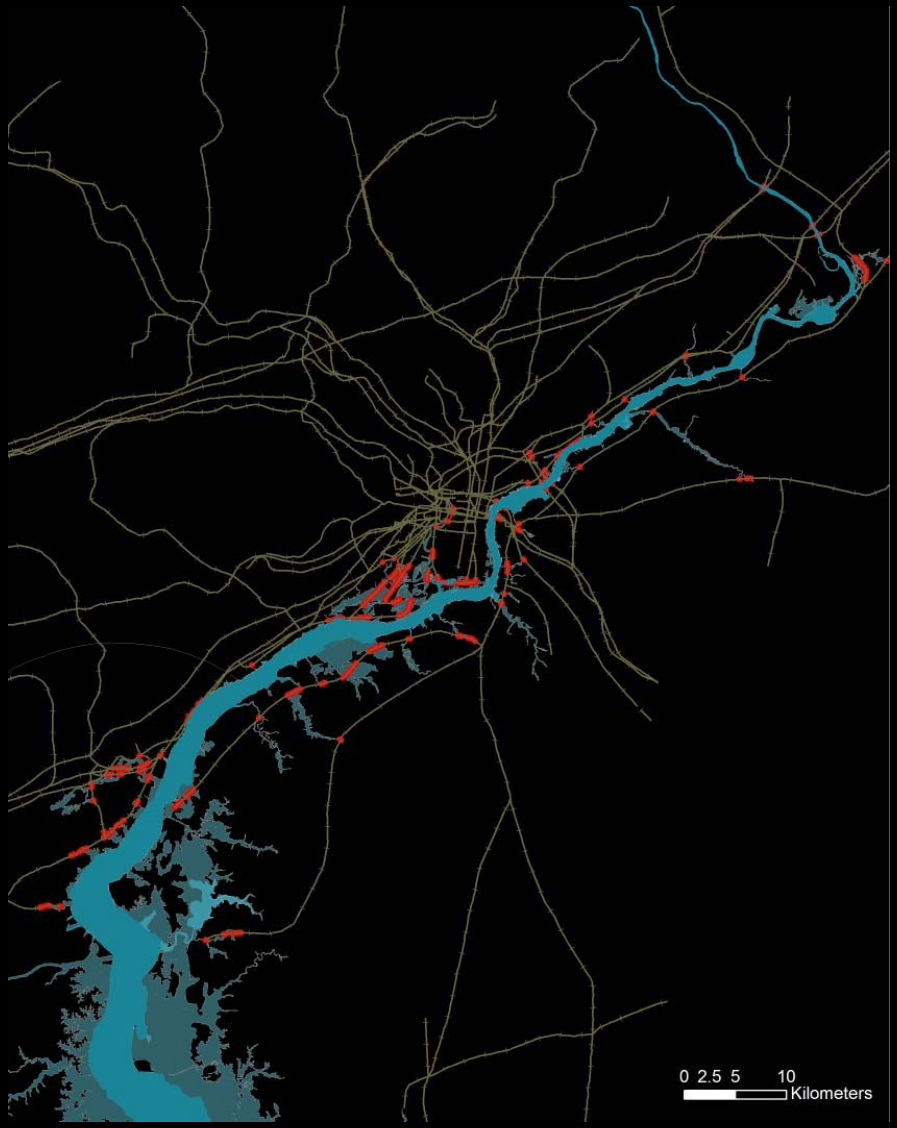
Clinn@dvrpc.org

Highways and Rail at Risk by 2100

Rail lines at risk of permanent inundation by sea level rise 2100



Transportation Infrastructure Currently at Risk as of 2100

	Flooding	*Estimated Cost*	Storm Surge	*Estimated Cost*	Sea Level Rise (permanent)	*Estimated Cost*
Highways	3,965 miles	*$7.1B*	689 miles	*$1.2B*	373 miles	*$1.4B*
Rail Lines	421 miles	*$2.1B*	124 miles	*$620M*	32 miles	*$768M*
Rail Stations	111 stations	*n/a*	25 stations	*n/a*	10 stations	*n/a*

Note: Cost may fluctuate by -25% to +70% based on urban areas, environmentally-sensitive areas, regionally, major river crossings, etc.

Rail Line

Sea Level Rise Rail Line 2100

Sea Level Rise 2100