

Climate Change, Human Activities, and the State of New Jersey

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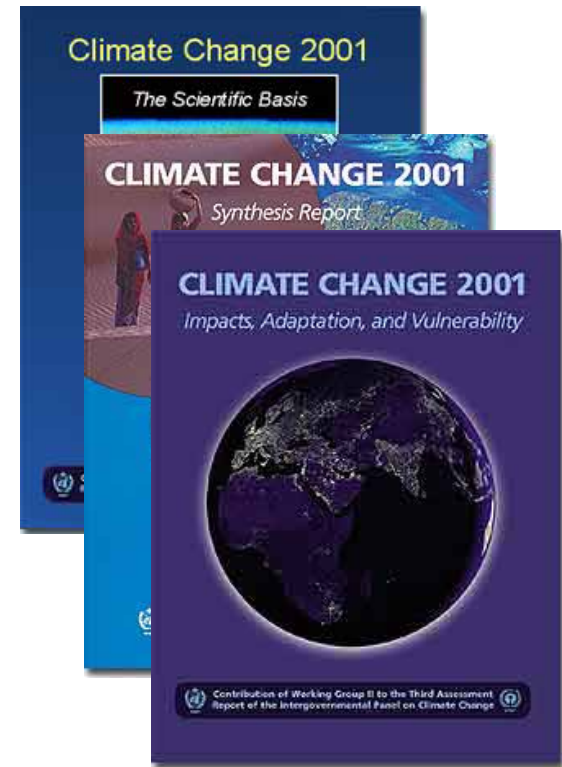


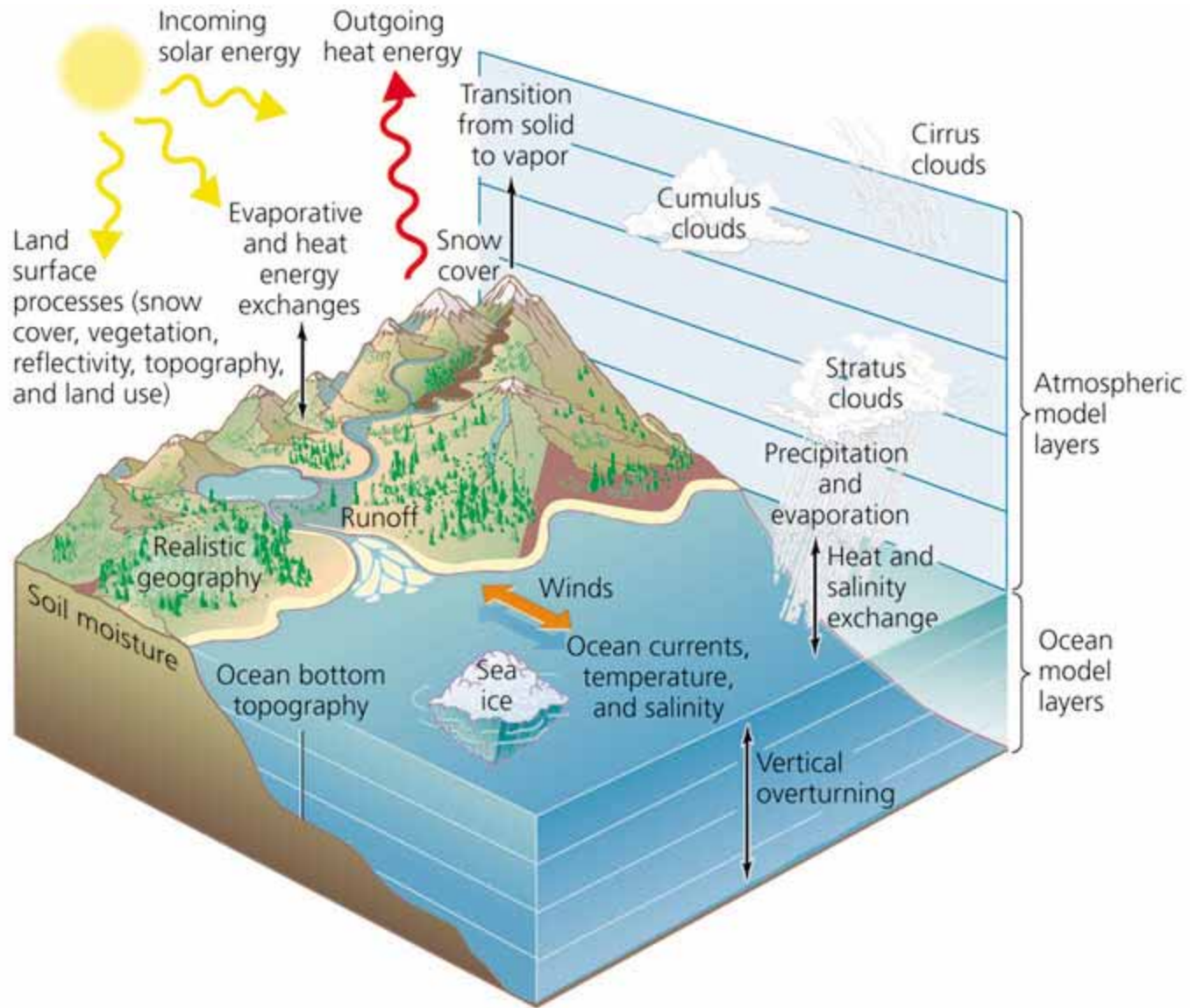


New Jersey
Climate
and
Environmental
Change

Conclusions from the IPCC (Intergovernmental Panel on Climate Change)

- ***An increasing body of observations gives a collective picture of a warming world and other changes in the climate system.***
- ***Emissions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that are expected to affect the climate throughout the 21st century.***





GREENHOUSE GASES



Carbon Dioxide

Methane

Nitrous Oxide

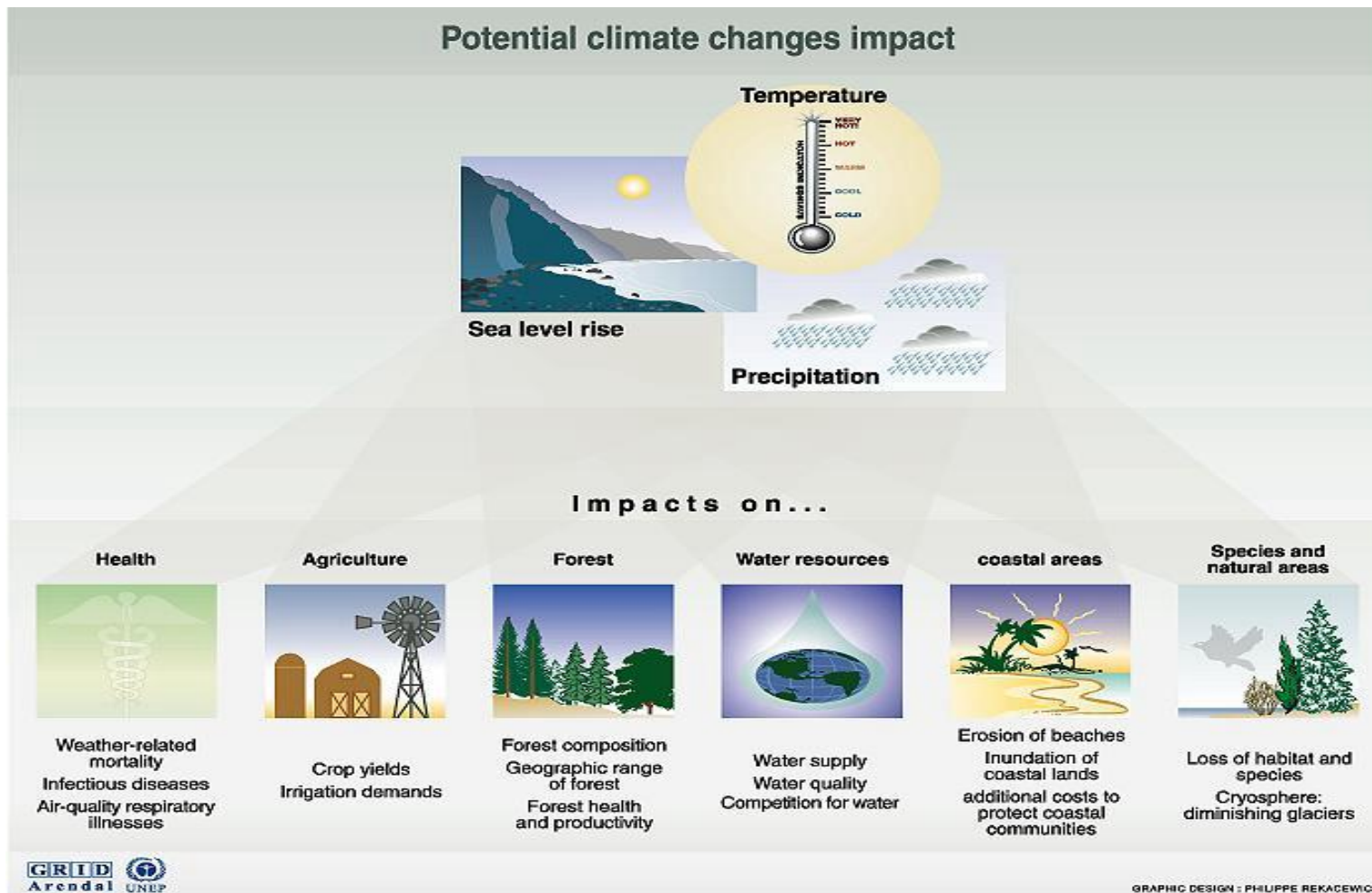
Ozone

Chlorofluorocarbons

Acidification

Biotic Impacts

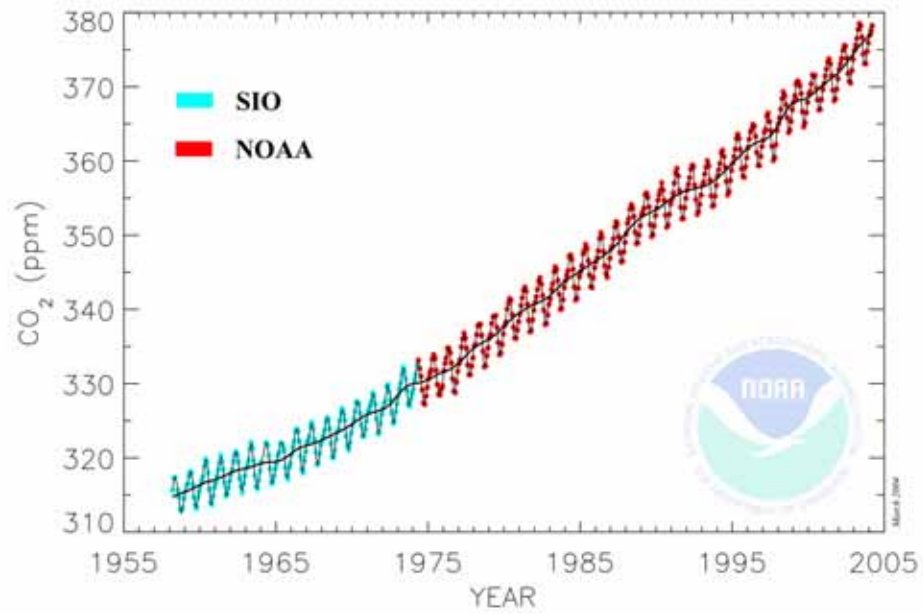
Global Warming Impacts



Source: United States environmental protection agency (EPA).



Mauna Loa Monthly Mean Carbon Dioxide



CARBON DIOXIDE EMISSIONS (NJ)

123.7 Million Metric Tons of Carbon Dioxide

NJ is Ranked 16th Nationally

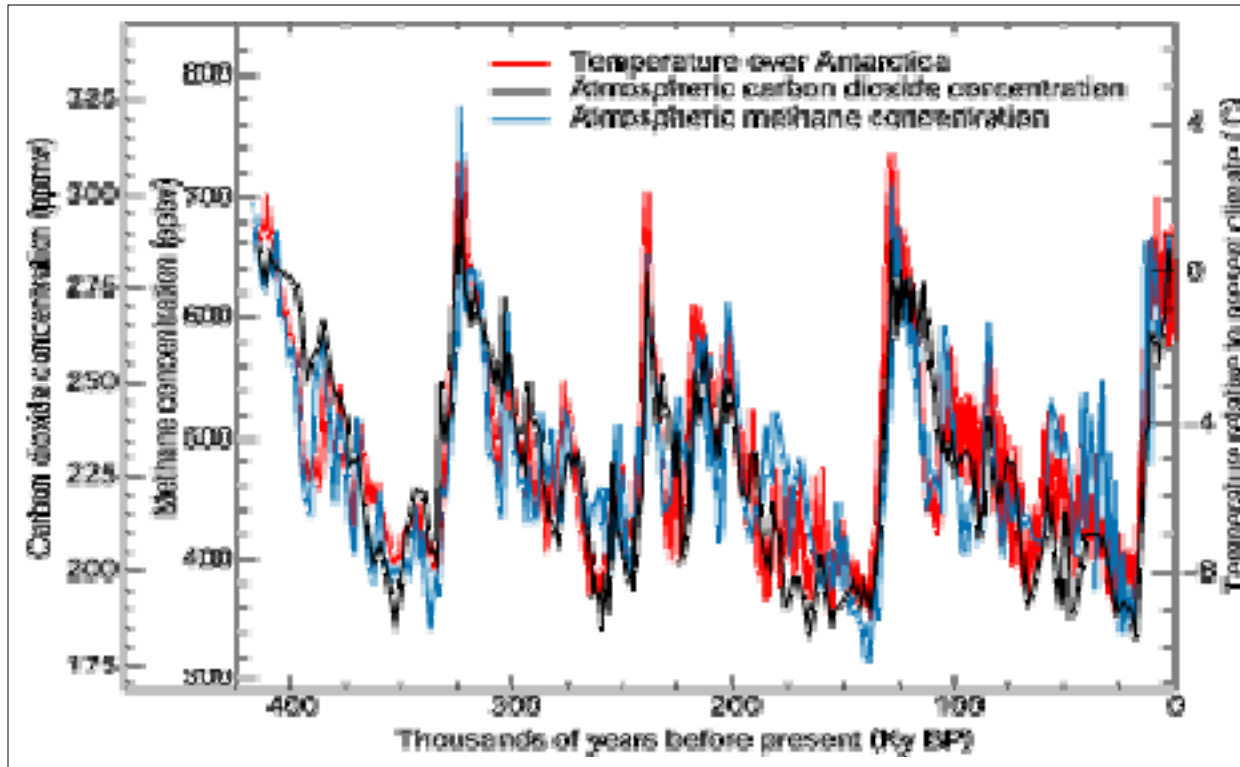
Emissions Grew by 8.57% from 1990-2003

37,000 Pounds of Greenhouse Gases Per Person

NJ Global Warming Response Act

80% Greenhouse Gas Reduction by 2050

GLOBAL WARMING *Lessons from the past...*

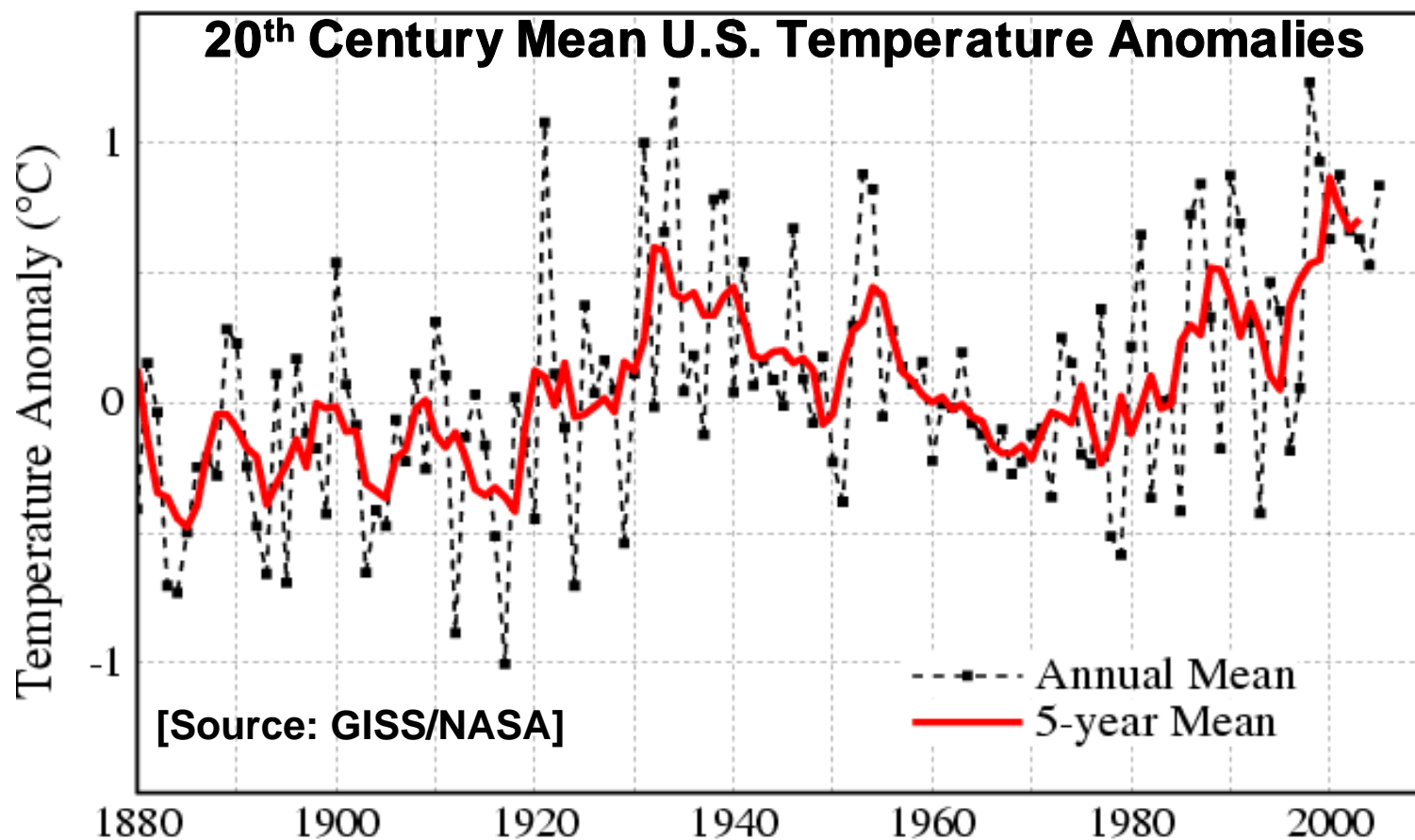


Until the 1970ies it was thought that the Earth's climate could change only slowly and over long periods of time.

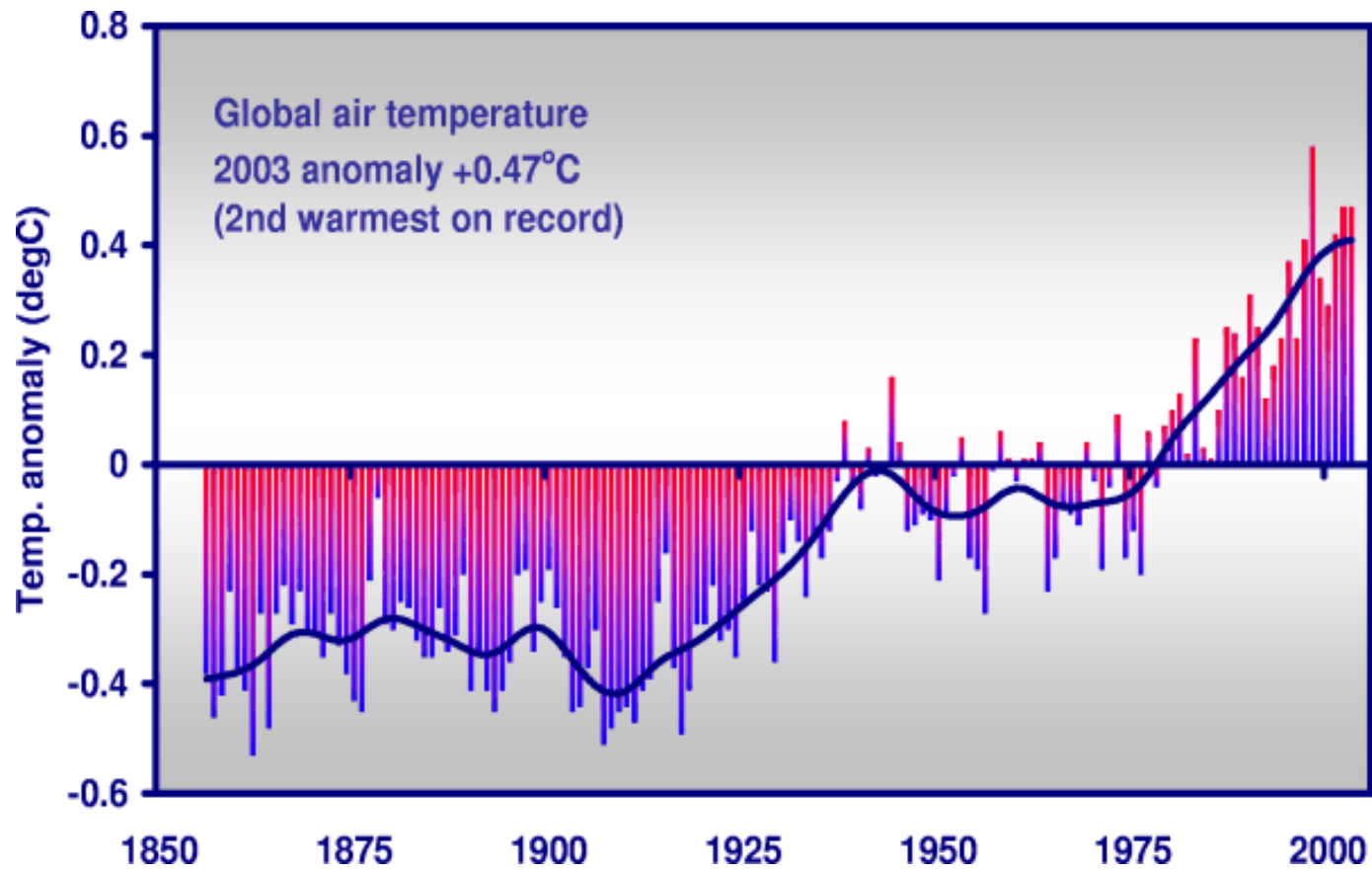
Ice core data showed that frequent and sudden climate changes were not uncommon in the past.

The grey color represents CO₂ concentrations, and the scale on the far left refers to the CO₂ values. As can be seen in the previous graph, pre-industrial levels (~280 ppmv) were similar to previous Interglacials (times which were not considered an 'ice-age' - as now). The present, post-industrial atmospheric level of CO₂ concentration is around 380ppmv, which on this graph would be off the scale. (IPCC 2001)

On Average, the US Warmed
0.5–1.0 °C in the Past 100 Years

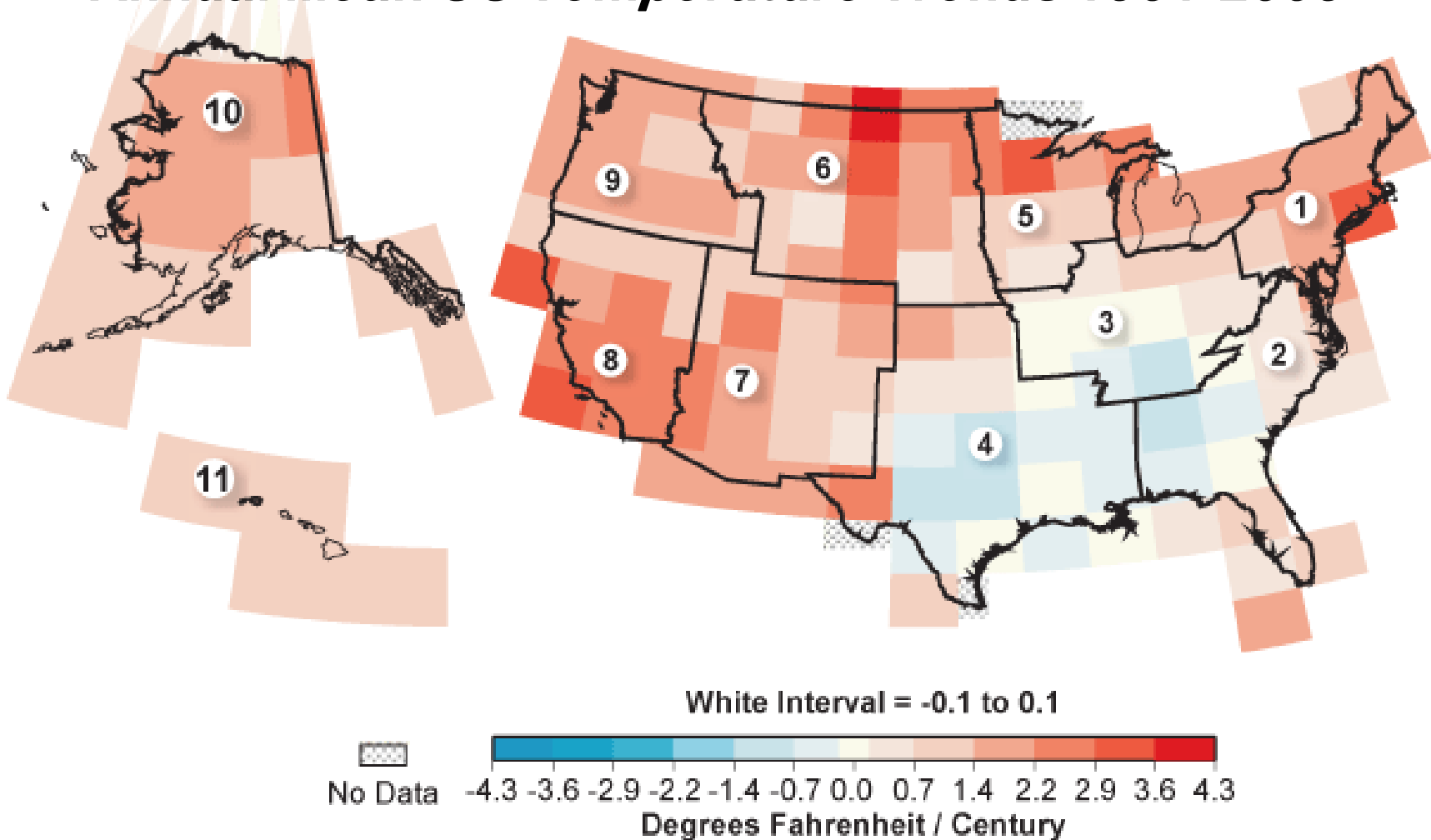


Global Air Temperature



Warming Trend Observed in Most of US

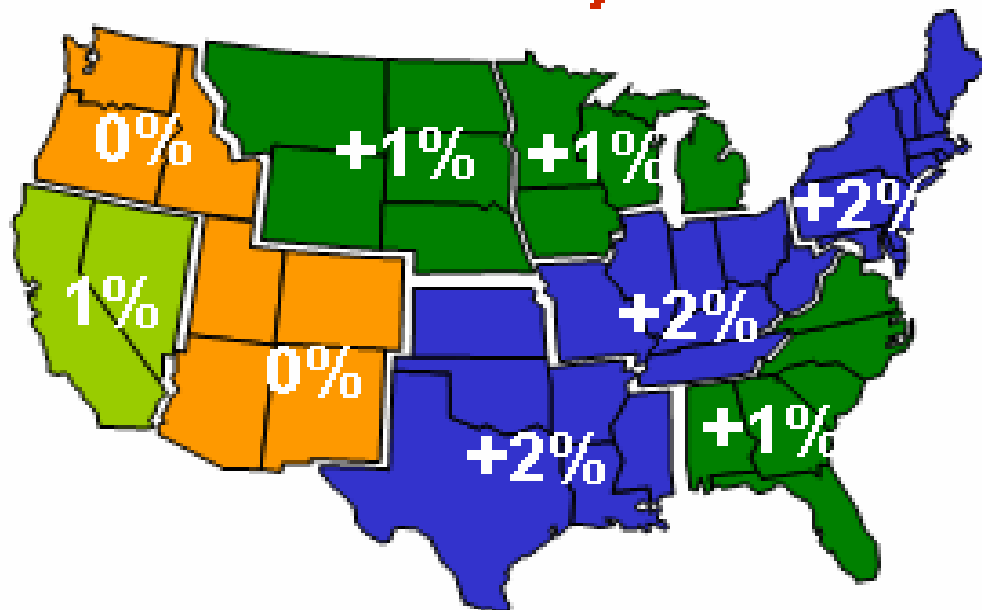
Annual Mean US Temperature Trends 1901-2003



Data from NOAA/NCDC; See: <http://www.epa.gov/climatechange/science/recenttc.html>

Precipitation Patterns Are Changing

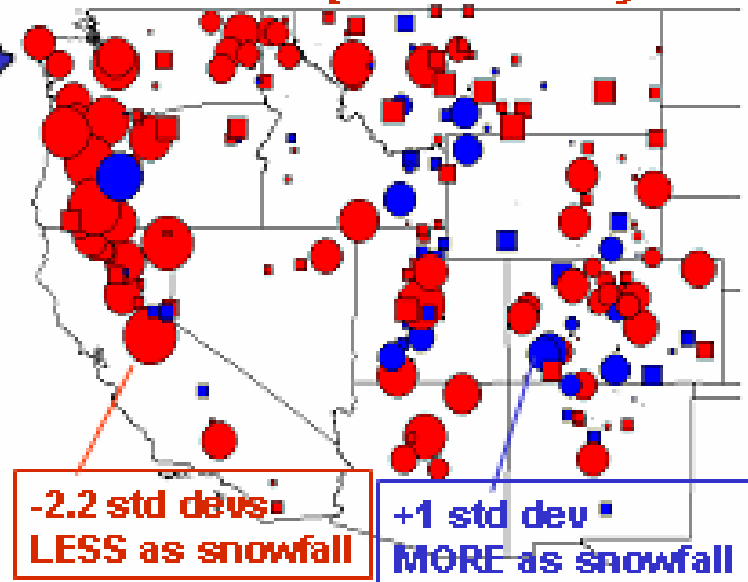
More precipitation from intense downpours



Trends in proportion of annual precipitation of extreme intensity (> 2" per day): 1910 – 1995

Karl & Knight 1998

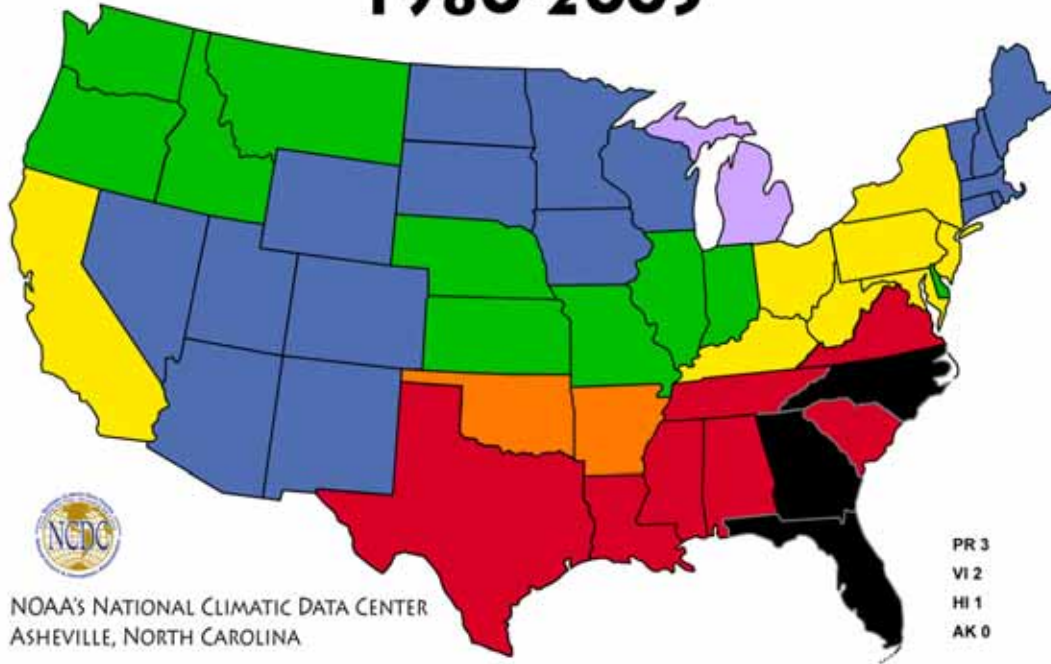
More precipitation as rain vs. snow (1949 – 2004)



Knowles et al. 2006



BILLION DOLLAR CLIMATE AND WEATHER DISASTERS 1980-2005



NOAA'S NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, NORTH CAROLINA

PR 3
VI 2
HI 1
AK 0

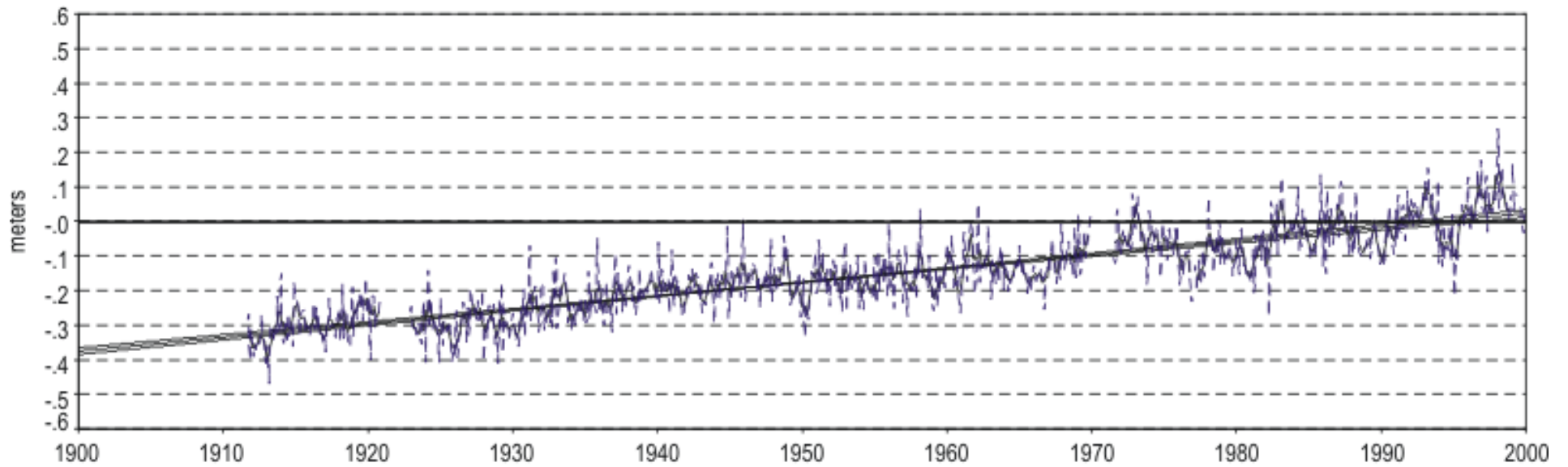
NUMBER OF EVENTS	DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	NORMALIZED DAMAGES (Billions of Dollars)	PERCENT DAMAGE
21 - 25	Tropical Storms/Hurricanes	24	35.8%	269	52.0%
16 - 20	Non-Tropical Floods	12	17.9%	55	10.6%
13 - 15	Heatwaves/Droughts	11	16.4%	145	28.1%
10 - 12	Severe Weather	7	10.4%	13	2.5%
7 - 9	Fires	6	9.0%	13	2.5%
4 - 6	Freezes	2	3.0%	6	1.2%
4 - 6	Blizzards	2	3.0%	9	1.7%
4 - 6	Ice Storms	2	3.0%	5	-1.0%
1 - 3	Noreaster	1	1.5%	2	-0.3%
		67		517	

Please note that the national map color-coded by state reflects a summation of billion dollar events, for each state affected—ie, it does not mean that each state shown suffered at least \$1 billion in losses for each event.

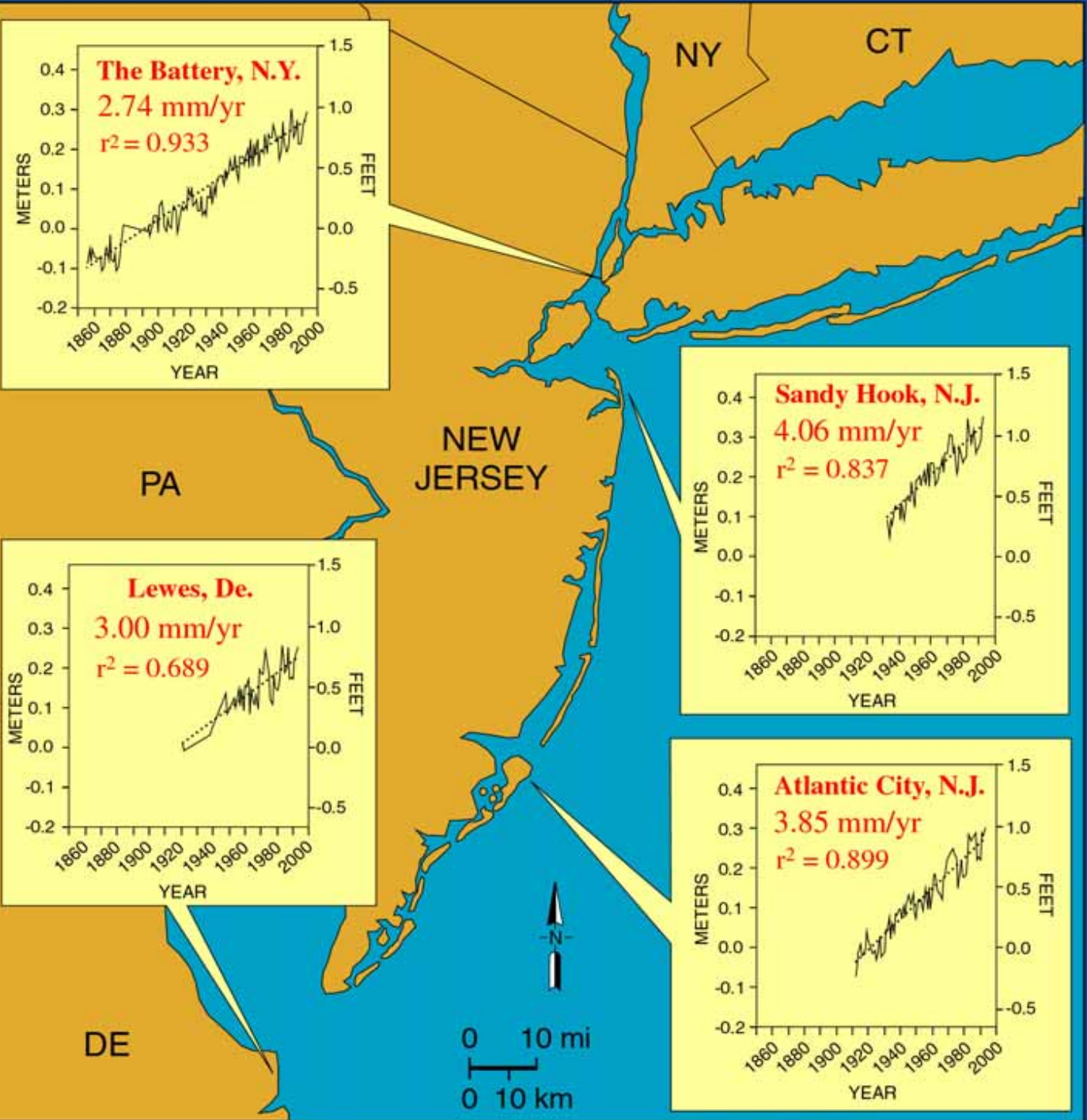
1. 24 OF 67 EVENTS (35.8%) WERE TROPICAL STORMS & HURRICANES
2. PRODUCED \$269 BILLION DOLLARS IN DAMAGES OR 52% OF THE TOTAL \$517 BILLION DOLLARS

Sea Level Trends in New Jersey

Atlantic City, NJ



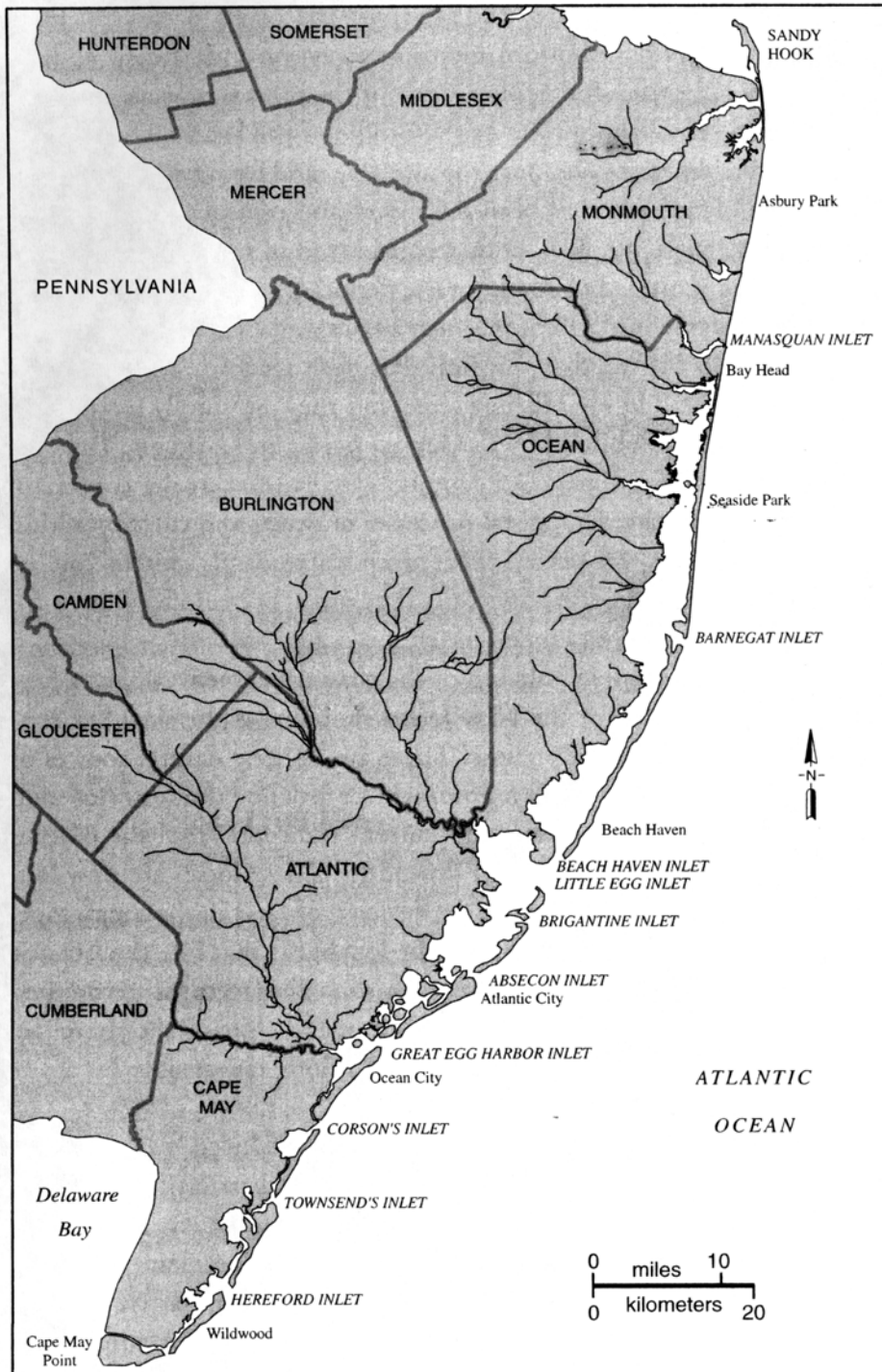
Source: National Oceanic and Atmospheric Administration





SUBSIDENCE ISOSTATIC ADJUSTING THERMAL EXPANSION

- **Modified Shoreline Habitat**
- **Degraded Wetland**
- **Accelerated Fringe Erosion**
- **Open Water Habitat Expansion**



Building Codes



Central Issues



-overdevelopment

-access

-environmental quality

-shore stabilization

An aerial photograph of a coastal town. In the foreground, a sandy beach is crowded with people. Behind the beach is a dense residential area with many houses. A prominent white water tower stands in the middle ground. In the background, a large body of water, possibly a bay or estuary, is visible, with a city skyline in the distance under a blue sky.

Low Elevation

**High
Population**

Coastal Paradox



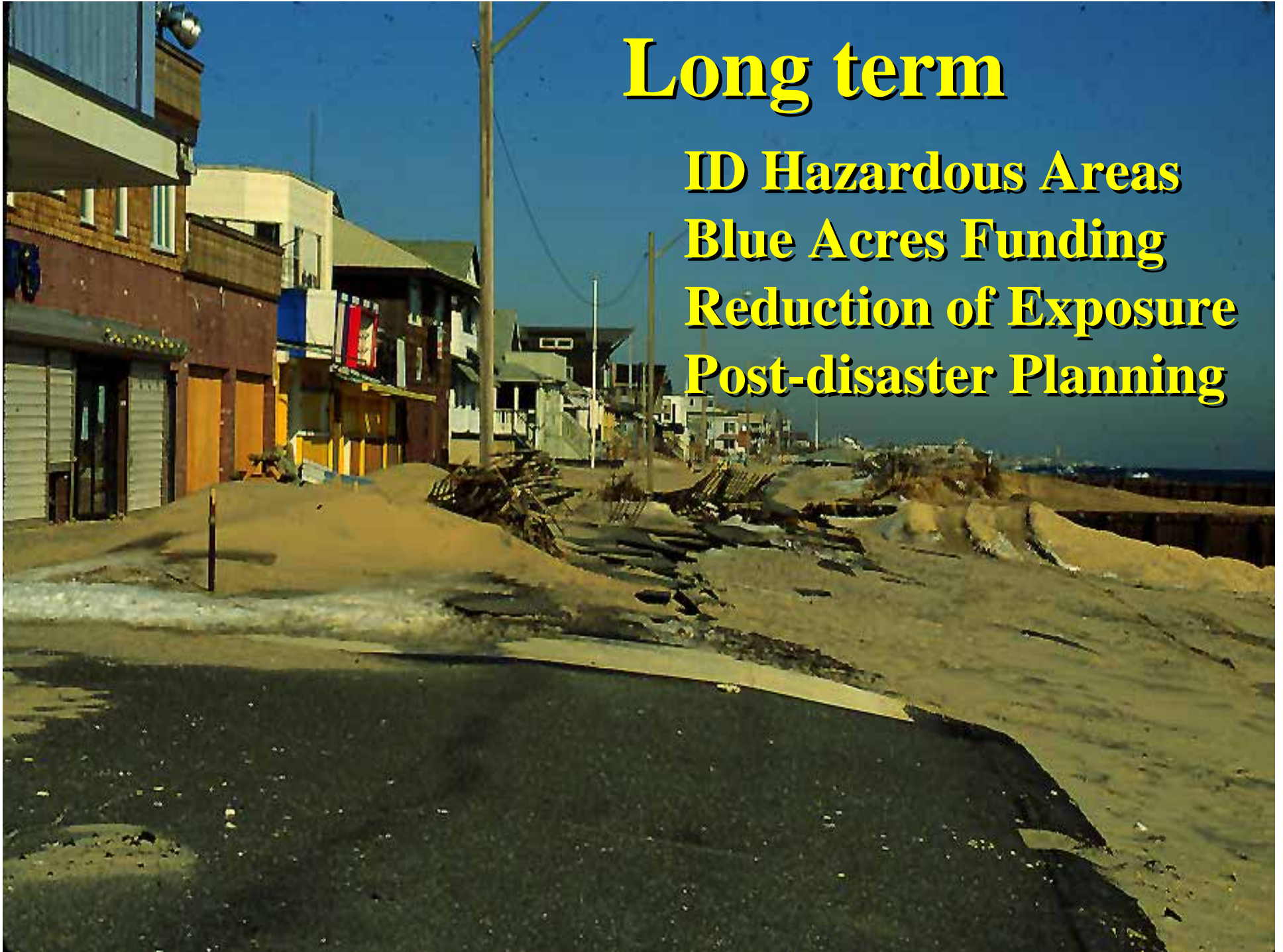
Greater Concentration People & Commerce
Changing Geomorphological Base
Erosion & Drowning





Long term

**ID Hazardous Areas
Blue Acres Funding
Reduction of Exposure
Post-disaster Planning**



Barrier Spit



With Beach Nourishment



Beach Fill



Static Land Use

Dynamic Coastal System



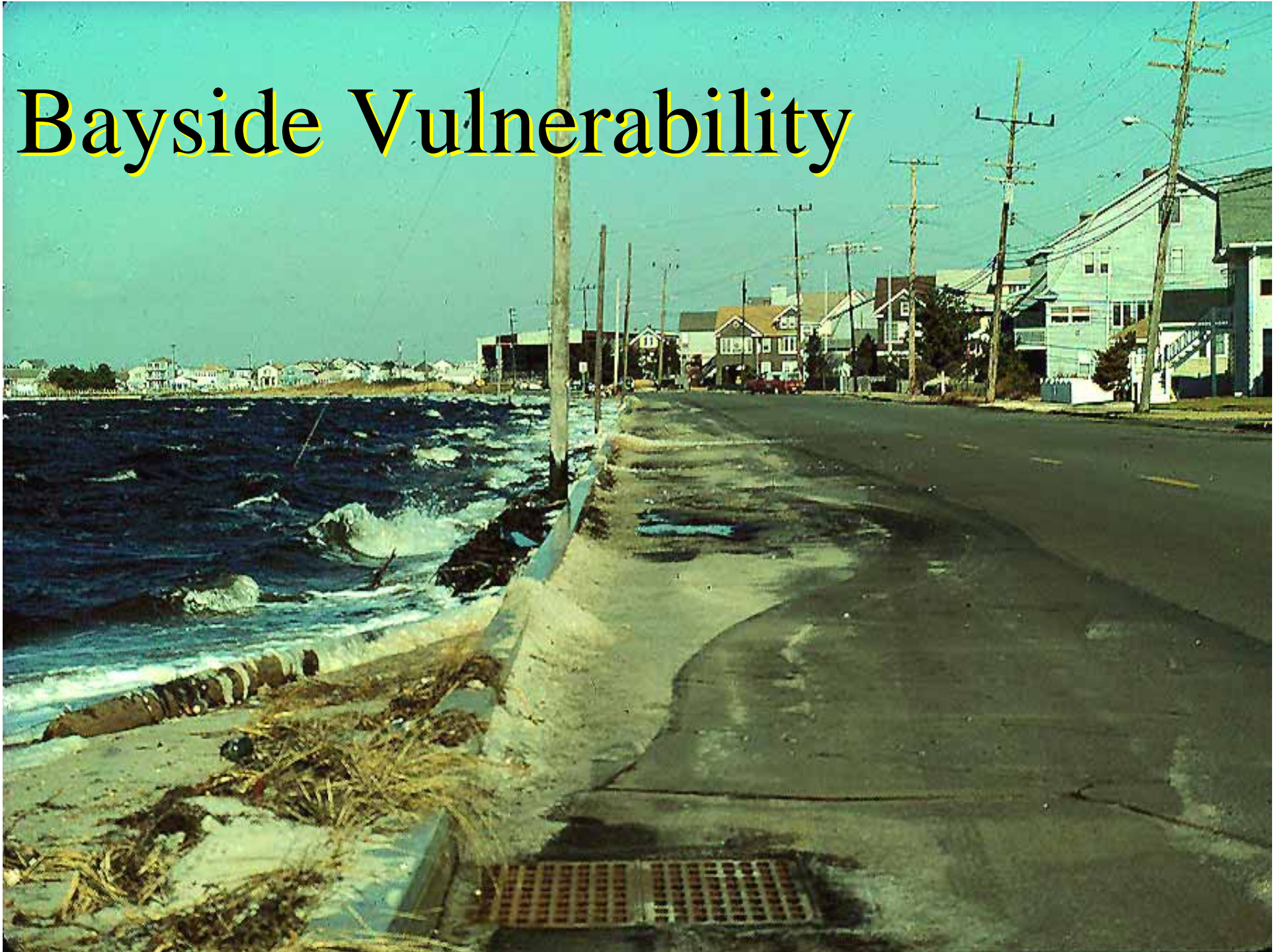
Improve Buffer



Restoration



Bayside Vulnerability



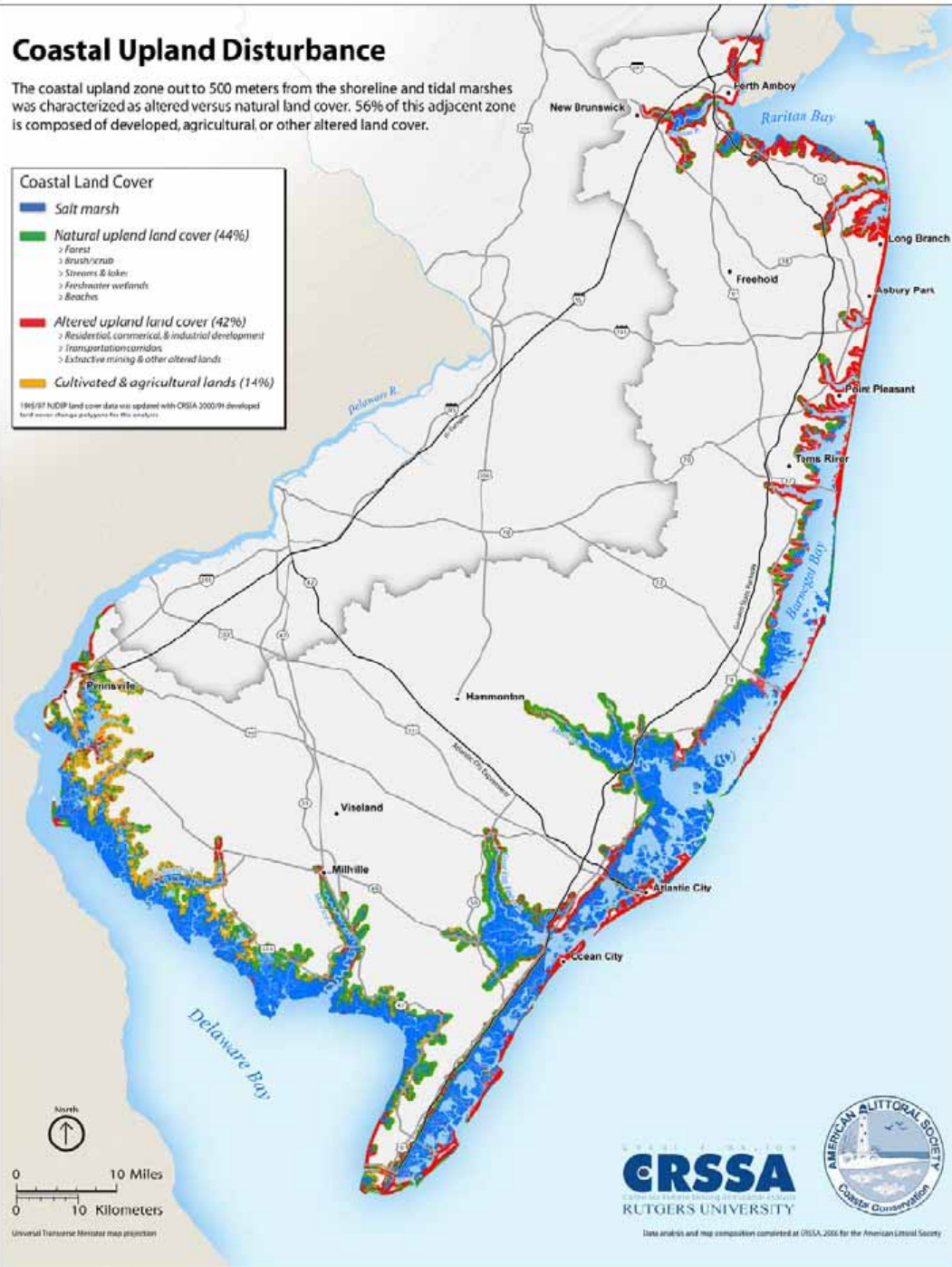
Coastal Upland Disturbance

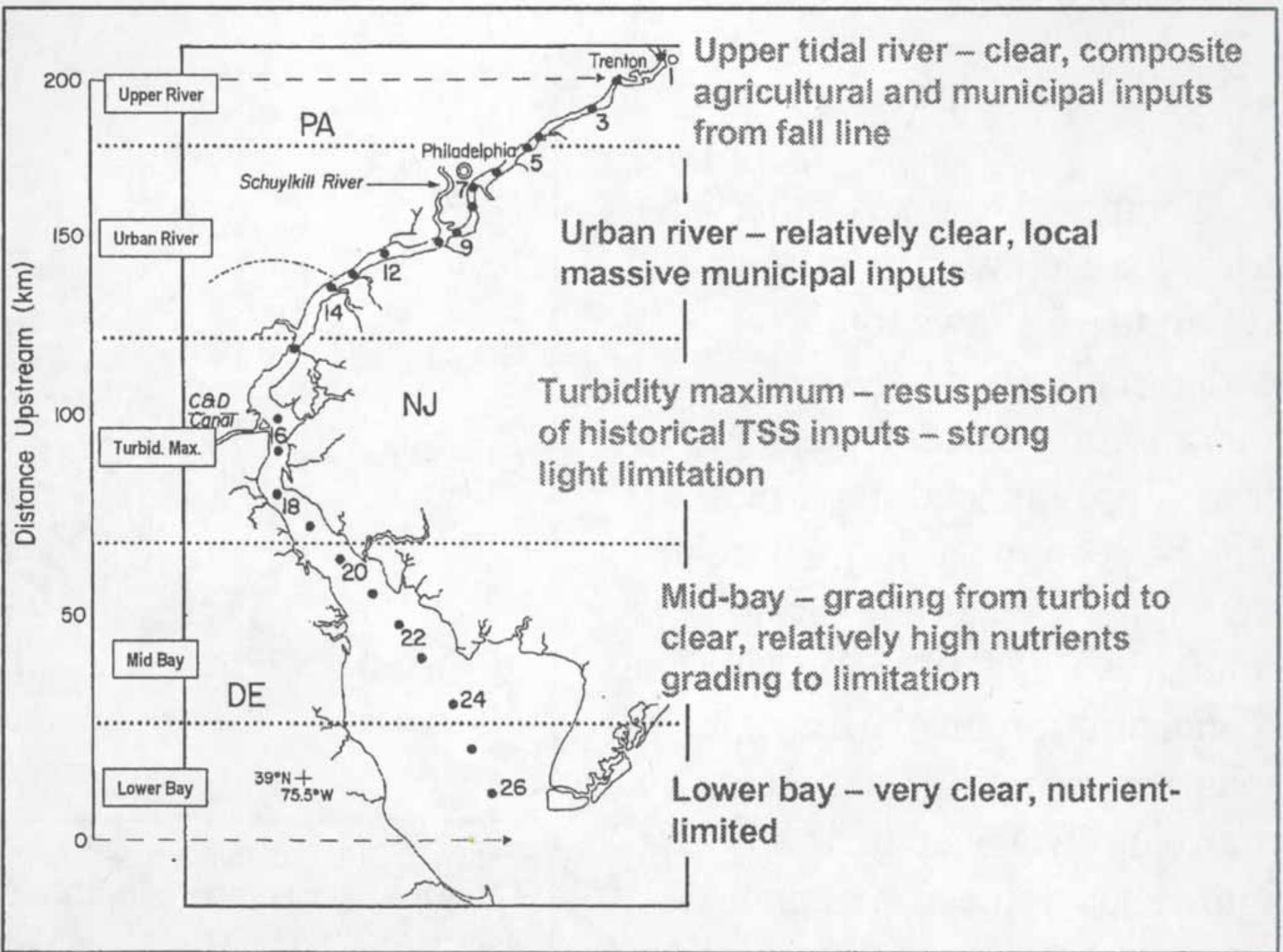
The coastal upland zone out to 500 meters from the shoreline and tidal marshes was characterized as altered versus natural land cover. 56% of this adjacent zone is composed of developed, agricultural or other altered land cover.

Coastal Land Cover

- Salt marsh
- Natural upland land cover (44%)
 - > Forest
 - > Brush/scrub
 - > Steepers & lakes
 - > Freshwater wetlands
 - > Beaches
- Altered upland land cover (42%)
 - > Residential, commercial, & industrial development
 - > Transportation corridors
 - > Extractive mining & other altered lands
- Cultivated & agricultural lands (14%)

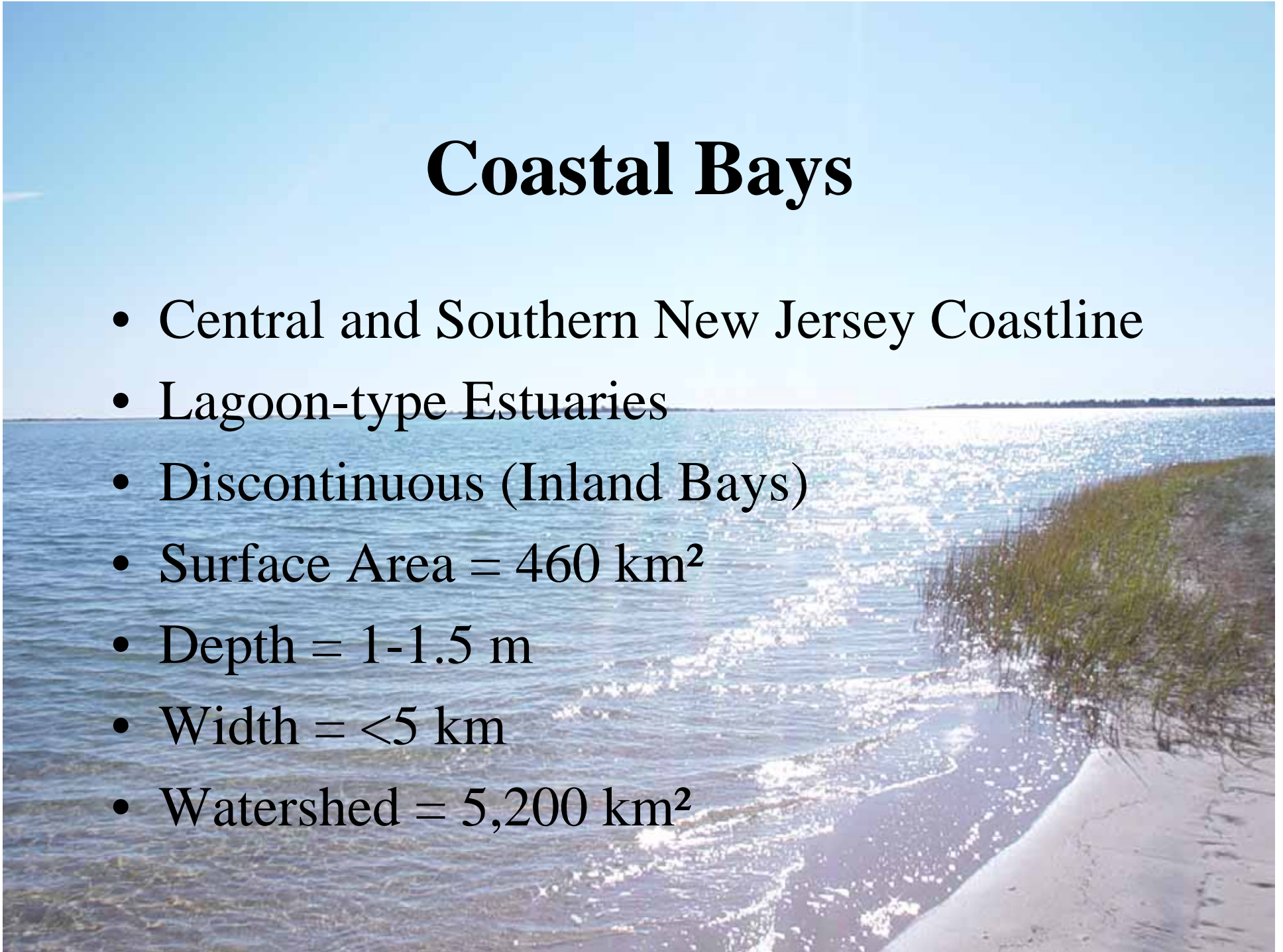
1985/97 NDOP land cover data was updated with CHSA 2000/04 developed land cover change polygons for this analysis.

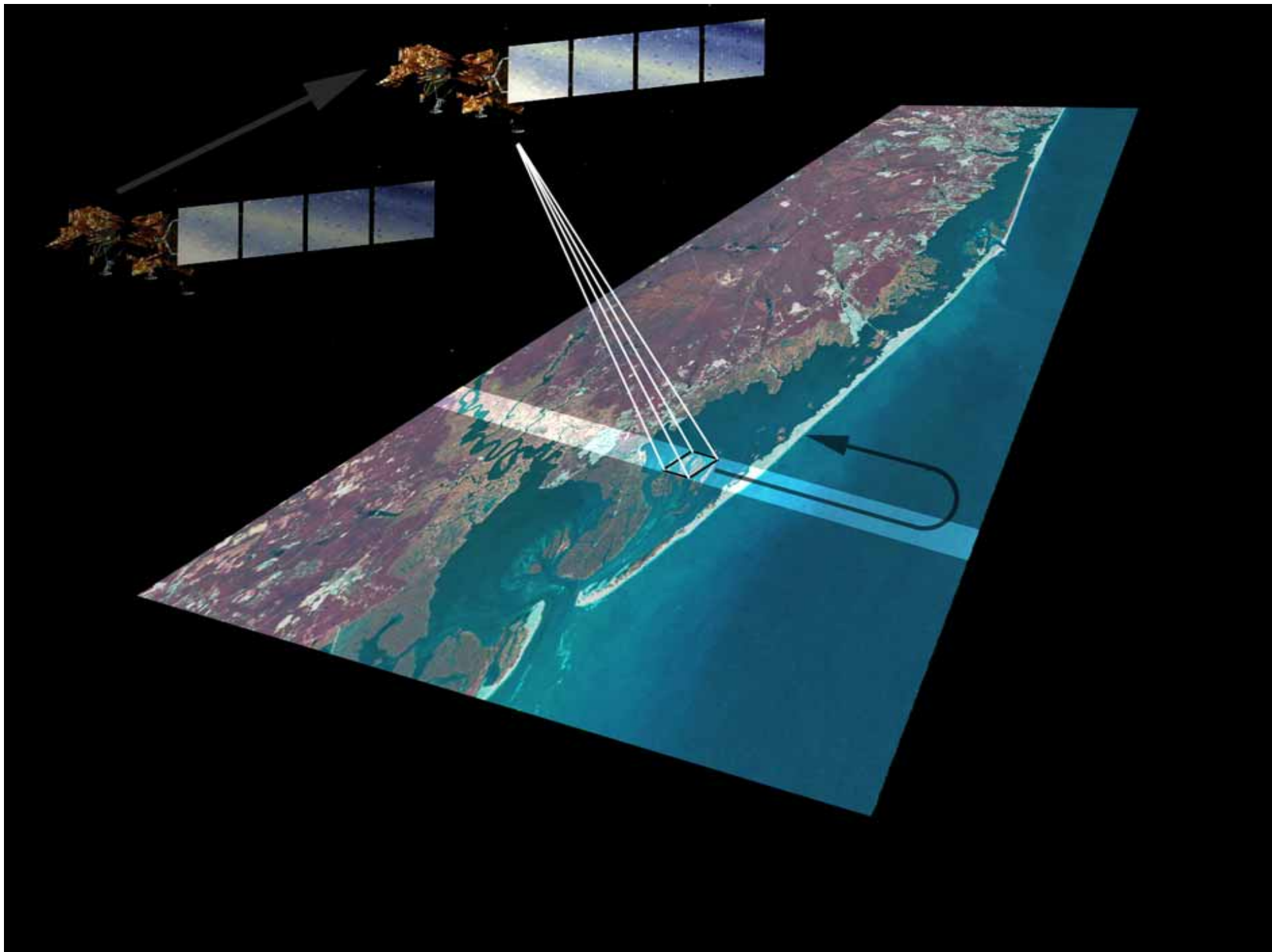




Coastal Bays

- Central and Southern New Jersey Coastline
- Lagoon-type Estuaries
- Discontinuous (Inland Bays)
- Surface Area = 460 km²
- Depth = 1-1.5 m
- Width = <5 km
- Watershed = 5,200 km²








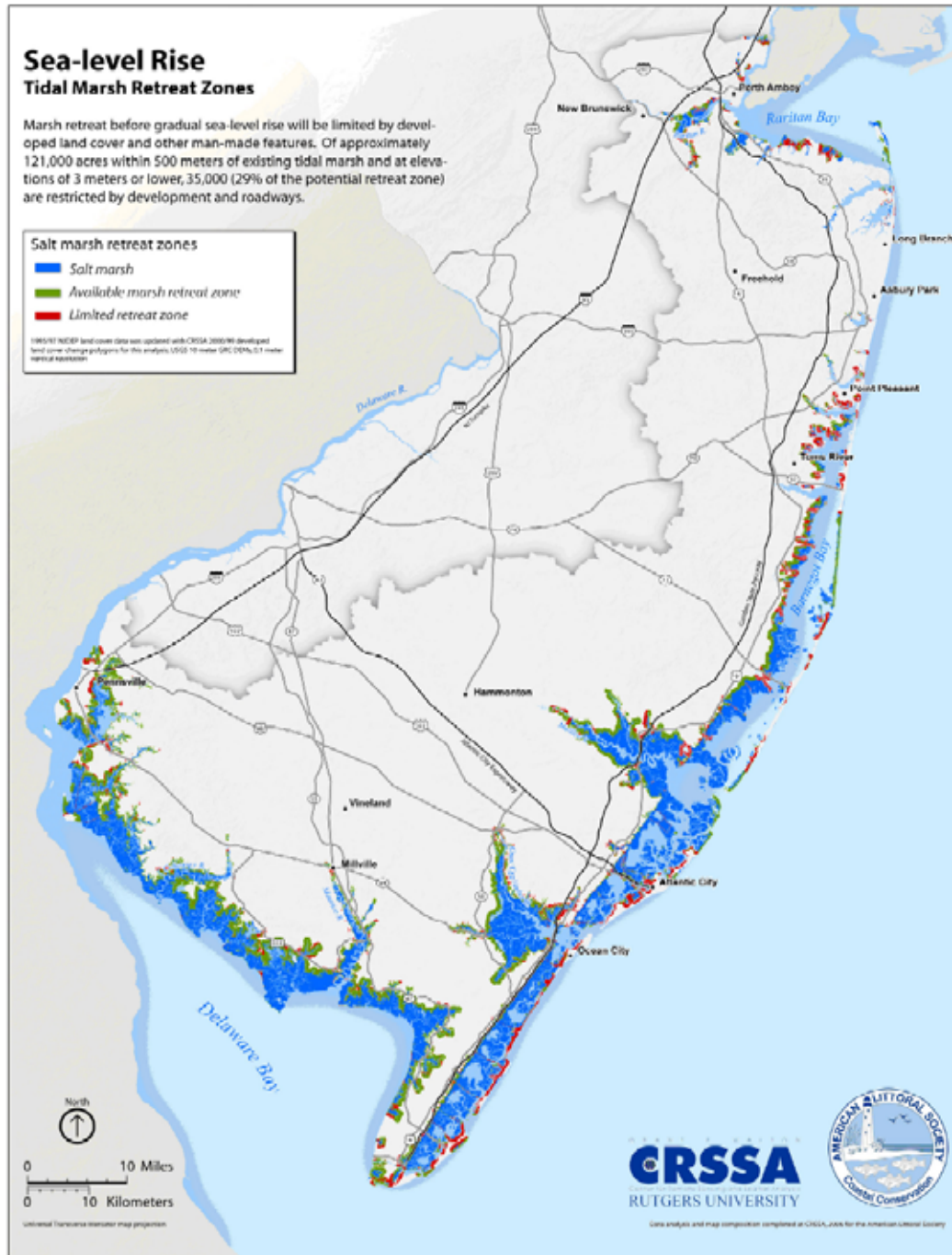
Sea-level Rise Tidal Marsh Retreat Zones

Marsh retreat before gradual sea-level rise will be limited by developed land cover and other man-made features. Of approximately 121,000 acres within 500 meters of existing tidal marsh and at elevations of 3 meters or lower, 35,000 (29% of the potential retreat zone) are restricted by development and roadways.

Salt marsh retreat zones

-  Salt marsh
-  Available marsh retreat zone
-  Limited retreat zone

1982-1992 NOAA land cover data was updated with CRSSA 2002/06 developed land cover change polygons for this analysis. USGS 10 meter DEM, 30m SRTM30 PLUS elevation data.



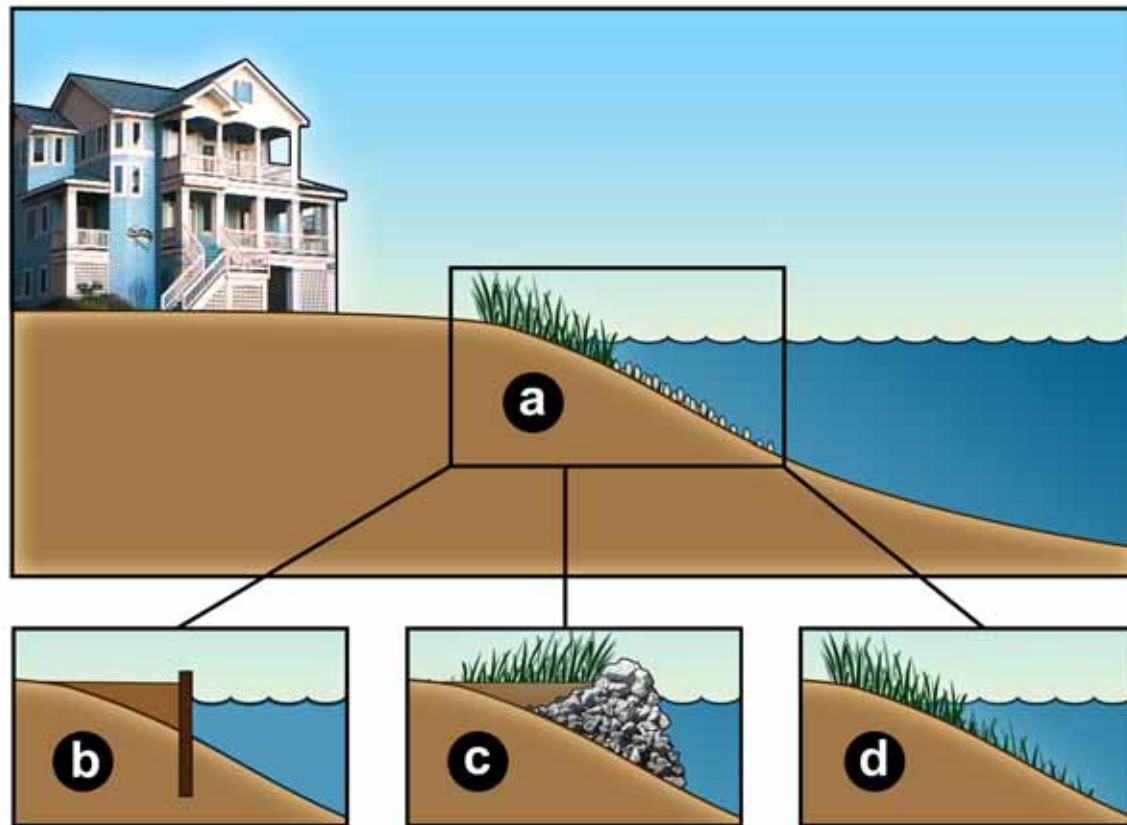
CRSSA
RUTGERS UNIVERSITY



Cost analysis and map composition completed at CRSSA, JARA for the American Littoral Society



Human impacts on shoreline alter response to climate change

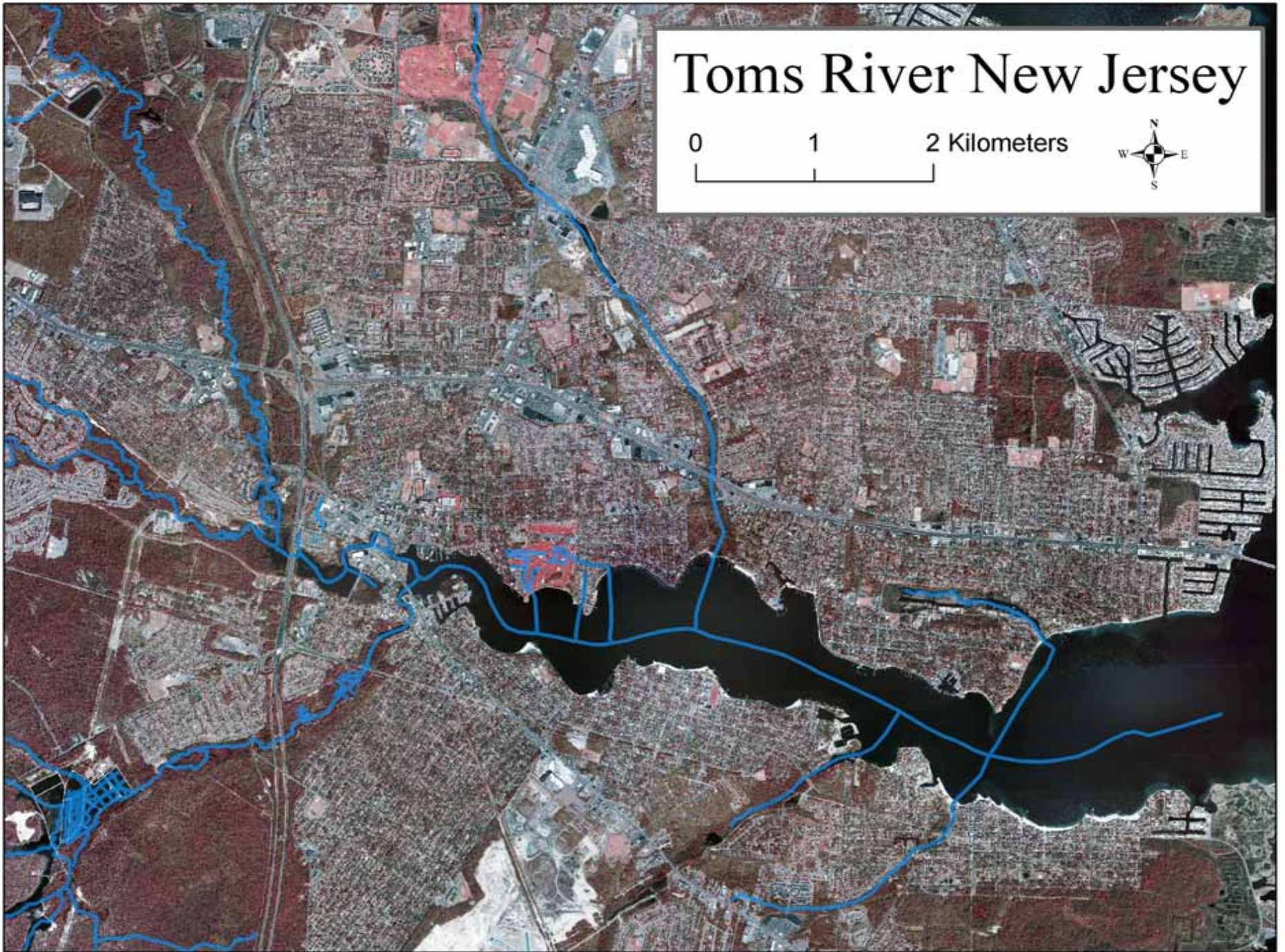


Pete Peterson, Mike Piehler, Rick Luettich and Chris Buzzelli



Toms River New Jersey

0 1 2 Kilometers







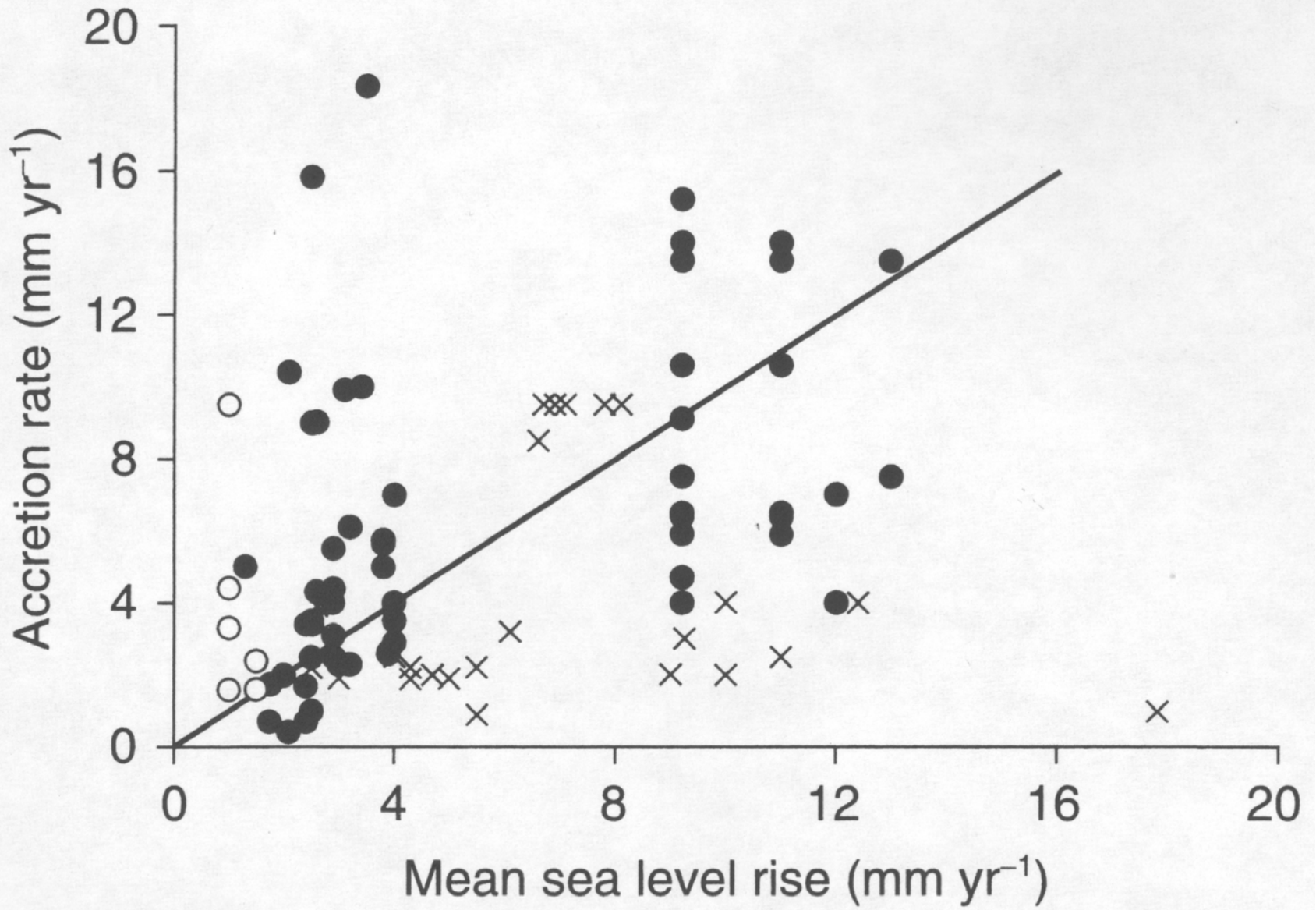






Marsh edge transfer

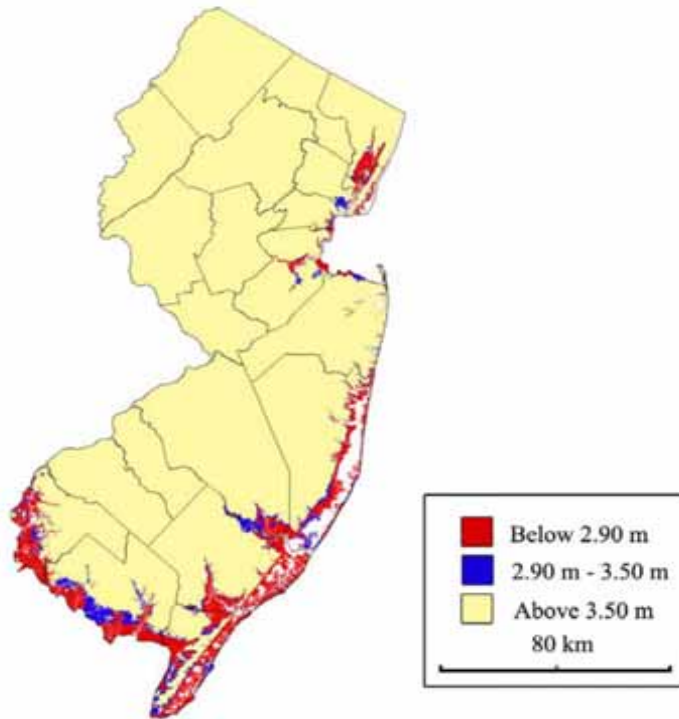




Impact of sea level rise on New Jersey

We will lose some land.

As sea level rises so does the potential flood impact



	Sea level rise (m)		
	0.61	1.22	2.90
	Area lost (km ²)		
Total	171	442	1251
Wetlands	83%	83%	72%
Forest	2%	2%	5%
Beach	3%	3%	5%
Urban	10%	10%	16%
Industrial	1%	1%	2%
Agriculture	0.2%	0.2%	4%

*What will be the economic and environmental impacts?
What should NJ do?*

Responses of Wetland Ecosystems & their Functions

- Functions
 - Biogeochemical
 - Hydrological
 - Habitat



**CHOWAN RIVER ESTUARY:
HIGH SEDIMENT BANK**



**PRE-HURRICANE
ISABEL 9/18/03**



**POST-HURRICANE
ISABEL 9/18/03**

SHORELINE EROSION:

**STORM = - 80 ft
LONG-TERM AVE.
= - 3 ft/yr**

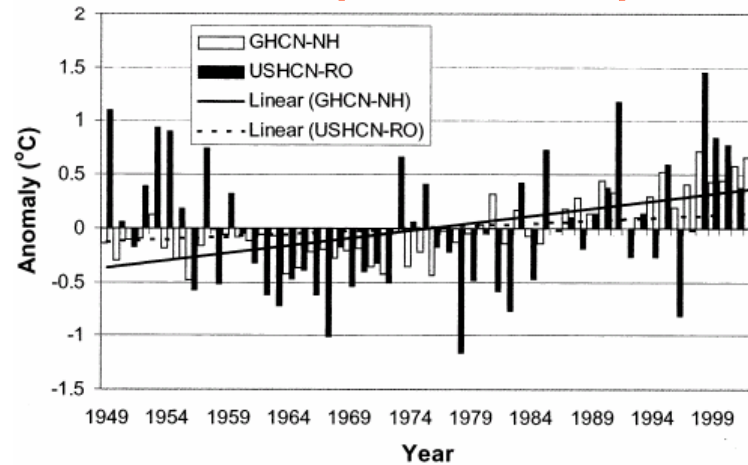
from Riggs & Ames 2003

Shore-Zone Modification in Response to Sea Level Rise & Disturbance

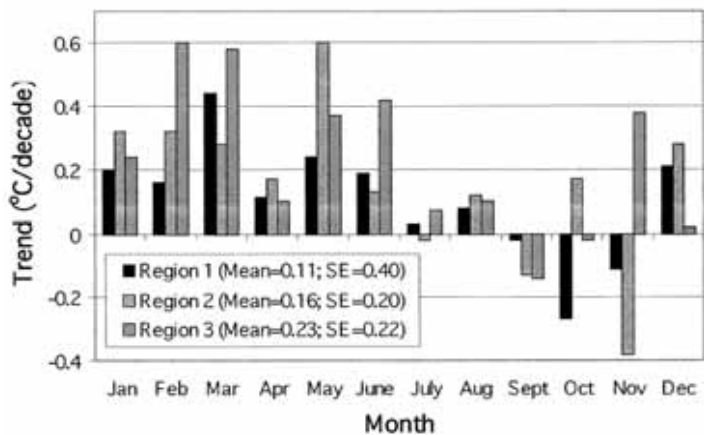


Estuaries Are Warming

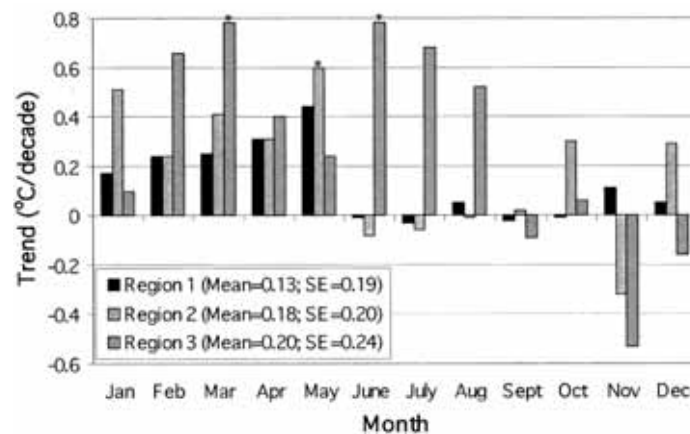
Chesapeake Bay warmed 0.8–1.1 °C (1949-2002)



Surface temperature trends

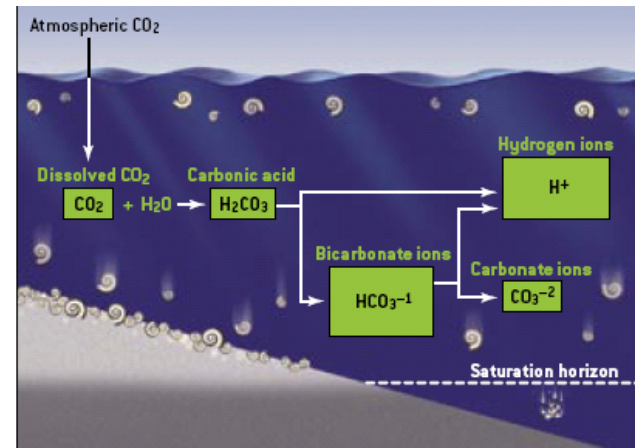
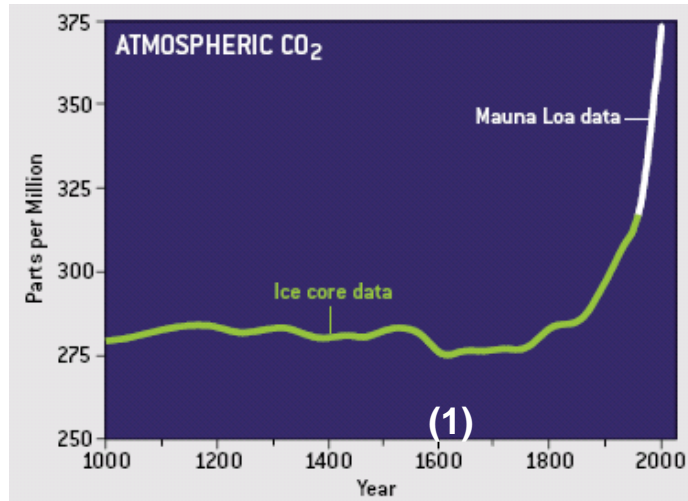


Sub-surface temperature trends



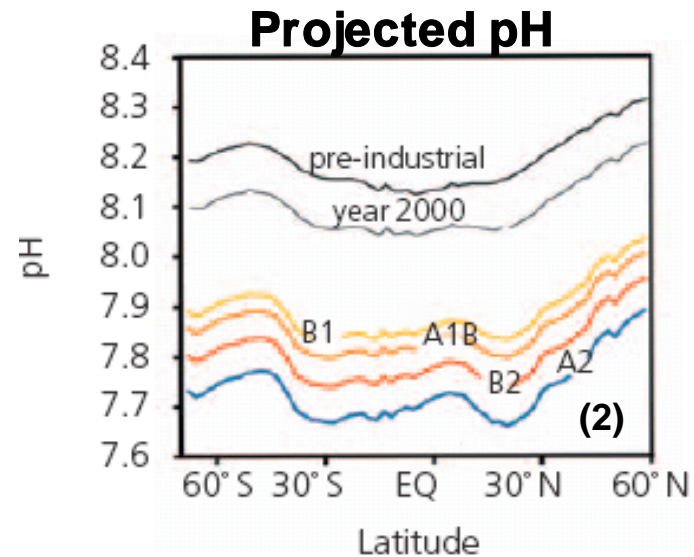
Preston 2004 Env. Mgt.

Ocean pH Is Decreasing



In past 200 years:

- Oceans absorbed $\frac{1}{2}$ of CO₂ emissions
- Ocean pH has decreased by 0.1



Sources: (1) Doney 2006, Sci. Amer.; (2) Royal Society 2005; (3) Kleypas et al. 2006, NSF/NOAA/USGS



SPECIES RANGE EXPANSIONS

- 36 of 39 Marine Invertebrate Species:
Poleward Range Expansions
- 24 of 24 Marine Zooplankton Species:
Poleward Range Expansions

(Parmesan and Yohe. 2003. Nature 421: 37-41.)

- Southern:Northern Coastal Bird Species
at Cape Cod (20th Century)
- More Southern Overwintering Species

(Valiela and Bowen. 2003. Ambio 32: 476-480.)





Picture of SAV bed from a boat

Atlantic Ocean

Island Beach State Park

Barnegat Bay

*Submerged Aquatic
Vegetation Beds*



CRSSA

-graphic by Scott Haag & Paul Montesano















TRACKING FAUNA

BIRDS

MAMMALS

REPTILES

INSECTS







NJ GLOBAL WARMING EFFECTS (2000-2100)

Surface Temperature Increase (1.4-5.8 deg. C)

Sea Level Rise (0.5-1 m)

Transgressing Ocean (Coastal Inundation)

Retreating Shoreline (20-30 m)

Barrier Island Overwash

Habitat Fragmentation and Destruction

Changing Aquatic Communities (<Biodiversity)

Landward Shift of Coastal Ecosystems (e.g., Wetlands)

Coastal Flooding

Saltwater Intrusion

Loss of Croplands

Displacement of Coastal Residents



Rutgers
Climate
and
Environmental
Change
Initiative
(CECI)

RUTGERS CECI

Climate Past, Present, and Future

Researching behavior of the physical climate system on both global and regional scales.

Coastal Environment, Infrastructure, and Communities

Researching climate change effects on coastal communities, ecosystems, and resources.

Education and Outreach

Developing and implementing undergraduate, graduate, and public education activities that further societal understanding of climate change.

Freshwater Resources, Ecosystems, and Agriculture

Researching climate change impacts on multiple components of terrestrial systems.

Human Health

Researching how climate change will affect human health and infectious diseases.

Human Dimensions

Researching the role of human behavior in both driving and mitigating climate change, and assessing the impacts of climate change on individuals and communities.



The End